Accidents from Fire-damp in Mines and the Means of Preventing Them.*

BY L. PARENT.

(*Concluded from page 135.*)

Let us suppose now that the dust is lighted by some exterior cause. That the distribution, more or less complete, of this dust liberates a certain quantity of oxygen in excess and uncombined in the cycle of secondary reactions, has in it nothing impossible; but that a movement should be established and that combustion should be kept up and propogated indefinitely is a thing more difficult to conceive if, without the intervention of hydrogen or hydrocarbon.

The transmitting agent is the vapor of water; this is the agent of oxidation beyond compare; in fact, the *dry* gases do not combine themselves under the influence even of the electric spark. We will suppose the watery vapor is separated into its elements:

$$2\,(H^2O) = 2\,(H^2) + O^2$$

To produce rotation or movement, the reciprocal phenomenon ought to produce itself, that is to say:

$$2\,(H^2) + O^2 = 2\,(H^2O)$$

We know that to reform the vapor of water, a temperature of 450° to 900°C is required.

Along with this will follow the combustion proper of the dust, with the production of a red flame; the complete combustion will give carbonic anhydride,

$$O^2 + C = CO^2$$

little adapted to sustain combustion, and it is necessary to admit that this carbonic acid is decomposed, at least partially, by the particles of red carbon into oxide of carbon

$$CO^2 + C = 2\,CO,$$

if not the combustion will be localized.

The two principal phenomena are then the decompositions of the vapor of water and the formation of carbonic acid; the first absorbs heat but the second disengages it. Thus 1 kilo (2.2lbs.) of water-vapor absorbs, for its decomposition into gas, 3233 *calorics*, and the 888 grammes (31.08 oz's.) of oxygen that it contains for their transformation into 1221 grammes (42.73 oz's.) of carbonic acid, 2,691 *calorics*.

As a consequence, admitting that the hydrogen remains in a free state, we must communicate to the water-vapor, so that the reaction may be continuous, a temperature of:

$$\frac{3233 - 2691}{0.4805} = 1128°\ C$$

But around this principal reaction different other reactions group themselves, some disengaging heat, others absorbing it. There should result from these movements a tendency towards a release of heat, but that the reaction may be continuous it is necessary that the watery vapor should have a temperature of about 900° C. The following questions arise, however: can this temperature exist, and is there sufficient water to permit this propagotion to become general? It is doubtful; first, the expansion of the gas plays an important part and has the effect of limiting the temperature and reducing the pressures developed in the explosion, and the combustion is more rapid as the velocity of the expansion is greater. The fall in caloric is very rapid and is measured by fractions of a second.

On the other hand, one kilogramme of dust contains only 9.7 grammes of hygrometric water, according to the anal ysis given before, this amounts to about 10 litres of vapor at the ordinary temperature. One kilogram of dust per cubic metre of air being considered as a maximum quantity, the augmentation of volume would be only about 1 per cent. from this cause; it is difficult then to explain the effect of projection and the enormous thrust established by it over some hundreds of metres of distance. But how can we explain the absence of accident, from the cause under discussion, in certain mines that are very dusty and not at all charged with fire-damp? In fact we can not regard the dust as having an exclusive role to play; while the presence of hydrogen, or hydrocarbon, even in small quantities, may serve to explain at least the succession of explosions if not the continuity of the reactions. Decomposed into its elements, by combustion or otherwise, the hydrogen protocarbide doubles the volume and furnishes the carbon and the incipient hydrogen. The products of combustion would be water and carbonic acid, and the cycle of reactions would be established as follows:

$$C\,H^4 = (H^2) + C$$

reciprocal reactions
$$\left\{\begin{array}{l} 2\,(H^2) + O^2 = 2\,(H^2\,O) \\ 2\,H^2\,O = 2\,(H^2) + O^2 \end{array}\right.$$

$$\left\{\begin{array}{l} O^2 + C = C\,O^2 \\ C\,O^2 + C = 2\,C\,O \end{array}\right.$$

(Marsh-gas, mixed with air, will only burn completely, so as to give carbonic acid and water, when the proportion is less than 9.5 per cent. The temperature of inflammation of hydrogen protocarbide is, according to M. M. Mallard and Lechatelier, about 780° C.)

The source of carbonic acid is, so to speak, continuous and a part passes to the oxide of carbon.

The effects of dispersion and combustion weaken each other; the clouds of dust partly distill, as the live flames and the explosions become more rare, and within a certain limited radius the locality becomes inhabitable so far as the heat is concerned, but still dangerous from the presence of oxide of carbon; this is why the number of workmen simply poisoned in an accident of this kind, is proportionally great. The spreading is explained by the combustion of the dust in a current of live and pure air, and by the lighting, in the roof of the galleries, of new mixtures rendered explosive by the presence of a small quantity of fire-damp. This gas may be supplied by fissures or may be simply lodged in the timbering; some mines are impregnated with fire-damp, and notwithstanding the apparent thoroughness of ventilation, no one can guarantee its entire absence.

III. *The Influence of Currents of Air with Regard to their Quality and Quantity.* First, with reference to the action of cold and dry seasons and of ozone. "The air descending into the mine acquires the same temperature as the works more or less rapidly; if the dew-point is originally higher than the temperature of the walls of the mine, it will deposit moisture; if it is lower it will absorb it. But the dew-point at the surface varies with the temperature and depends entirely upon it; so that when the temperature is cold, it is low; when the season is warm, it is high. On the other hand, it is well known that the temperature of the soil is constant at about 15 metres (50 ft.) depth, and that it increases at the rate of 10° Centigrade for each 33 metres (100 ft.) of additional depth in the coal regions of France. This being so, it is evident that we can quickly reach a depth at which the mine will have a temperature more elevated than that which corresponds to the dew-point at the surface, at any season of the year; and if there is no leakage water, or artificial sprinkling, the currents of air passing through the mine ought to be perfectly dry at all times.

"I will not attempt here to exactly fix this depth; I can only say that it will be found between 120 and 210 metres, and that cold will not only occasion great dryness in non-water bearing mines, but will also change into dry mines, while it lasts, a number of those which are usually damp.

"Considerations of this kind lead me to the conclusion that the very low temperature existing in the beginning of December, 1875, had a very considerable influence upon the explosions which happened in the mines of New Tredegar, Swaithe and Llan, on the 4th and 6th of that month. I expressed these views in my deposition in the enquiry made into the Llan explosion, and read by me before the Royal Society on March 2, 1876. I remarked that the carbonaceous dust, by reason of the abnormal meteorological conditions, was dryer and more inflammable than usual. If the variations of temperature were examined, before and after these explosions, it will be seen that just at that moment the temperature touched a very low point; and, undoubtedly, the relative dryness of the works of all three mines was greatly increased, and the coal-dust more easily ignited than at other times." (MR. GALLOWAY.)

The meteorological observations made at the Park of St. Maur, when properly examined, lead to interesting results in the case of the Lievin accident and confirm the views of Mr. Galloway as expressed above. These figures show, in effect, that in the 24 days preceding the 14th of January, the mean rainfall per day was not one millimetre, and the mean temperature was about one degree below zero; snow did not fall until January 9th, and about the 14th the weather was cold, with snow.

Influence of the Quantity of Air. The volume of air which traverses a gallery has a value which ought to be in a direct relation to the importance of the accident, especially when the air is pure. A gallery of four square metres in sections traversed by a volume of air of eight cubic metres, for example, represents a velocity in the gaseous thread of 2 metres per second; they would thus have great propagating power. But in regard to this matter, we can only accept known facts, and encourage those who are attempting to improve mine ventilation, without criticising too much. The powerful devices for ventilation now at our disposal, enable us to combat successfully all variations of the atmospheric pressure.

The action of ozone has never been made the subject of examination. Nevertheless, it ought to assist, in a certain measure, in the aggravation of accidents from dust. It may be derived either from slow oxidation or from the atmospheric air. It is a powerful agent in oxidation, burning with cold organic substances, and these latent phenomena of combustion, so to speak, (1) may pass into the midst of the dust deposited on the timbering; at the moment of active combustion, if the elevation of temperature reaches only 300°, it is converted into oxygen with an augmentation of volume of one third.

Peroxide of oxygen = 2 volumes of ozone = 00^2; at 300°, 00^2 = 000. conditions very favorable to the increase of explosive effects.

We know, from the observations at Montsouris, the winds from south and south-west are charged with ozone, and that the proportion is maximum in December; and if we consult the weather charts, we will remark that a series of equatorial winds commence to show themselves on the 30th of December, and continue without interruption until Jan. 11th.

IV. *The Influence of an Air Current with Regard to the Point of Origin of the Accident.* A mine is a multiple organism, of which one of the functions is the ventilation. In a well established mine, this function consists of: 1. An organ of emission, which is the shaft for the descent of fresh air, usually the working shaft. 2. The arteries or principal galleries conducting the pure air to the various sections of the mine, represented by the different levels being worked. The main air current is divided, for the ventilation of each of these sections, in such manner that each thread has its own particular duty to perform; each of these currents after having vivified its section

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(1) It is possible thus to explain the formation of latent azotic acid which, at the moment of elevation of temperature, combines with the ligneous dust proceeding from the bark on the timbers and forms an explosive.

ascends to an upper level; there, it reaches, by a road more or less lengthy a collecting gallery. This collecting gallery leads back the impure air to a receiving organ which is called the return-air shaft and is surmounted by a ventilating apparatus acting by suction. Such is the ventilation of a mine in good working condition.

In this organism, however, certain peculiarities enter when the work is preparatory, and when the workings are ascending or descending veins, etc. Such works, with regard to ventilation, are characterized by the feature that the air is only able to reach the working chamber by an abrupt change in direction. They have been, as other portions of the mine, the theatre of accidents, due to fire-damp, but rarely from dust; and in all such cases there is not one where the accident spread to other section.

It is easy to understand why this is so. To commence with, the dust is in minimum quantity in the new portion of the mine; but more than this, the air flowing to the front of the working, expands and turning comes back by a road parallel to the first track but distinct from it. The velocity due to such air currents ought to be expressed by zero, and an explosion occurring in a mass of air almost without motion, or in an eddy, is not able to spread abroad its effect.

By applying this principle to each particular case, we will have an explanation of each of these accidents, whether they took place in a vein, or in a side or main gallery. Whenever an explosion occurred in a section where the air was relatively stagnant, or with little motion, it could only reach and make victims of those within a radius of 13 to 25 feet, but the murderous effects of the fire are confined to this zone and do not spread. On the contrary, should the accident happen in a principal gallery where the air circulates with a velocity of 2 meters per second and more, the explosion is able to repeat itself, spread and again repeat, making new victims and sometimes extending over the whole mine (1)

V. *Measures to be taken.* To form conclusions in such cases is always serious work. We may, in effect, be putting an insurmountable obstacle before those who have to work mines charged with fire-damp; but in any state of the case it is better to give some conclusion than none at all, we will lay down the simple results of our observations, and commence by repeating the advice of Mr. Galloway.

"In conclusion, we see that the explosions caused by the accident under discussion should be attributed either to the passage of a flame, occasioned by a sound wave passing, across the netting of a burning lamp, into an explosive mixture, or to the combustion of carboniferous dust raised and ignited by incandescent gases. I am now fully convinced that it is to this last cause that most of these accidents are due. We can guard against the action of the sound wave by using lamps which will not burn in an explosive mixture; and the carbon dust can be made harmless by an abundant application of water. These two remedies are simple, especially the second, and both are urgently required for other reasons; this would seem then more rational than to suppress the use of powder for blasting even in the fiery mines.

"And also a general rule has been introduced into the Act regulating coal mines, of 1872, making it obligatory upon the proprietors of mines to place a barometer and a thermometer at the entrance of all coal mines."

(1) "Without doubt, by the energy of the ventilating currents, we have, in proportion to the number of laborers in a mine charged with fire-damp, a less grand total of explosions; but each local explosion which occurs becomes general by reason of the velocity of the air current, or tends in this direction." (CHANSELLE *Industrie Minerale*, 1877.)

These recommendations are excellent. As to lamps, we can say that the new electric lights are more safe than the lamps with wire gauze. As to the thermometer, it will not be sufficient simply to note down its indications, it will be necessary to apply them to the improvement of ventilation. The application of water in the galleries to render the dust harmless is only a palliative; and consequently as such, and apart from any special case, should be rejected; in fact, without counting the expense, such application, to be judiciously made according to the conditions, would require special training in the miners, if this is not done properly we but augment the transmitting power of the dust. We say the same thing of the chloride of calcium. The preliminary sweeping of the gallery, suggested by M. M. Mallard and Lechatelier, is again only a mitigating effort; it is the usual story of the broom which displaces the dust in front of it only to throw it to the sides. All of these systems are vicious; it is necessary that the temperature of the mine be maintained at a point of humidity, beyond the control of the workmen, and then we believe the solution is general.

We will say then; that the dust may be explosive with or without fire-damp, that is the enemy; and as we cannot suppress it, it is necessary to prevent it becoming dry.

"For example, we can take the case of a dry mine, in which the temperature of the works is 21° C. During the warm season the air which descends the shaft has, we will say, a temperature of 15° to 16° when it enters the descending air current; at that moment, it is also saturated with watery vapor, for this water can be usually seen in a condensed state trickling down the sides of the shaft. The temperature is gradually raised as the current approaches the headings, and ends by touching its maximum after having passed over the face of the newly quarried coal. During this passage, the humidity has also been increasing in a certain sense, but always remaining below the saturation point in an ordinary mine.

"When the season is very cold, on the other hand, the same current may sometimes have a temperature of zero, or even lower, when it touches the bottom of the shaft; and when it has passed through these same works its temperature will have been raised as before to 21°. It is evident then that, in this last case, the air current ought either to take into the mine a surplus of moisture (about 8 grammes per cubic metre of air), or be much drier at each point of its course than in the first case." (GALLOWAY).

It is necessary then to observe the dew-point at the bottom of the shaft, each day, so as to know the exact quantity of water we should inject into the air so that it may be always saturated; we should also note each day, that point in the mine where the air current has acquired the temperature of 15° or 16°, which location we might call the "zone of equilibrium." Beyond that, it would be useless to supply moisture, but it is to be feared that in winter this zone penetrates very far into the mine. To remedy this, we would suggest:—that the air be supercharged with moisture; by reason of its velocity, the air-current will, if the liquid is sufficiently divided, carry mechanically this excess of humidity far enough to reach the limits marked by the zone of equilibrium.

No special labor will be involved in this system if the volume of water transported is in proportion to the air volume and its temperature.

We will take for example: volume of air entering the shaft, 40 cubic metres per second; section of shaft, 10 square metres; velocity of the air filaments, 4 metres; temperature 0° C.; difference of tension between the watery vapor at temperatures from 0° to 15° = weight of water furnished per cubic metre = 12.6 — 4.6 = 8 grammes; it would furnish 0.320 kilos. per second, say 1152 kilos per hour, or 1.152 cubic metres.

If the shaft was absolutely dry and the air completely devoid of moisture, it would be able to furnish 12.6 — 0 5 = 12.1 grammes, or 1.742 cubic metres of water per hour, the very *worst* conditions in practice.

But there is another enemy to be guarded against, that is the shots in blasting; as we can not suppress these we must render them inoffensive.

No engineer would wish to suspend ventilation during blasting, and we would not recommend any such practice. The accident at Frameries was probable due to a stoppage of ventilation. The practice of reducing the speed of the ventilating fans during the night is also to be condemned.

Applying our preceding observations, we would recommend the creation, by the means indicated, of an atmosphere relatively tranquil, or one opposed to combustion.

The first point to be made is to set aside certain hours in the day for exploding the blasting charges, and during these hours to slacken the speed of the ventilating engines to a degree, to be determined for each case and place, calculated to reduce the propogating effect. We will not here pretend to fix exact rules for this operation of firing the charges, but would suggest as follows: Proceed by distinct sections, but in such manner as to expose no one to danger; as soon as the men charged with the duty of firing the charges have performed their task they should give the signal for the reduction in the normal speed of the ventilator, which should go to work again progressively until the gas is evacuated. The workmen then proceed to their posts.

To create an atmosphere unfavorable to combustion, it would suffice to burn without deflagration some material (in the powder for example) giving off carbonic acid, and leaving the mine at the moment this gaseous stopper passes through it; this could easily be accomplished by using electricity in firing the charges. We would welcome an explosive so prepared with carbonic acid, either liquid or solid, as a desideratum; for dynamite, while it lessens the danger from explosions, can not be used generally in coal mines; and, on the other hand, the numerous experiments with lime have not yet given certain results.

Such are the conclusions that we believe we have formulated and to which we call the attention of engineers, and seek to provoke discussion in their application to mining practice.

Work on the Chicago, Wisconsin & Minn. R.R

THERE are so many railroad schemes now-a-days which exist only on paper, that it is refreshing to be able to give from the very best authority direct information relating to a bona fide undertaking. Referring to the paragraph about a recent large railroad contract we are informed by one of the contractors that:

The railroad contract made for the Wisconsin Central Extension, which is known as the "Chicago, Wisconsin and Minnesota Railroad," and running from Schleisingerville to Chicago, was let to Harrison and Green of Milwaukee. The roadbed and bridges are to be made ready for the iron by December 1st, next. The road is 116 miles in length, and whilst the country is comparatively level the work to be done involves the moving of thirteen hundred thousand (1,300,000) yards of earth; sixty thousand (60,000) yards of rock; requires two million (2,000,000) feet of timber, and one hundred thousand (100,000) feet of piles, and will require for its construction 2000 men and 600 teams and teamsters. Thus a force of 2800 men will be necessary to accomplish what is reported by the papers to be done by 500 men. The work is now in active progress and force is being added to daily.

Yours very truly,

S. A. HARRISON,
13 Colby Block, Milwaukee, Mis.

"The Purification of Water by means of Iron on the large scale."*

BY WILLIAM ANDERSON, M. INST. C. E.

During the sesion of 1882-83, in a Paper on "The Antwerp Water Works,"[1] the author had the honor of bringing under the notice of the Institution an adaptation of Professor Bischof's method of purifying water on a large scale by filtering it through a mixture of spongy iron and gravel. The operation of the process, as far as the effect upon the water was concerned, left nothing to be desired; uninterrupted work for nearly four years did not appear to have materially enfeebled the power of the filtering medium, nor to have sensibly diminished its quantity. Two defects, however, very soon became apparent. First, the filters, dealing with the exceptionally impure waters of the Nethe, proved incompetent to purify more than half the quantity of water expected; and, secondly, the upper layer of the mixture of gravel and spongy iron gradually hardened into a crust, and became clogged with slimy matter to such an extent as to render it necessary periodically to uncover the purifying medium, loosen its upper surface, and wash away the deposits which had accumulated. But the very circumstance that these operations became necessary, affords the strongest evidence of the potent action of iron.

The purifying beds were, in the first instance, covered with a layer 2 feet deep of fine filter sand; the water was allowed to subside for at least twelve hours before it was admitted to them, and therefore must have reached the iron in as pure a state as ordinary subsidence and sand filtration could bring it to; and yet, the moment the surface of the iron mixture was reached, action took place so energetically, that not only was the mixture itself affected in the manner described, but the influence of the iron seemed to extend even upwards, as was evidenced by the discoloration or the sand for 2 or 3 inches above the iron.

These facts, the author considers, are a conclusive answer to those who, in the discussion on the Paper referred to, alleged that simple sand filtration would attain the same results as those which had been reached by the iron method. The deposit which caused so much trouble was a mixture of salts of lime and magnesia, derived from the softening of the water, and of organic impurities partly rendered insoluble by the action of the iron, and partly curdled up into a condition too gross to pass through the filter bed.

It is hardly necessary to remark that no deposit of impurities is ever found between the sand and gravel of ordinary filter beds, hence the impurities deposited at Antwerp must have been separated by the action of the iron. The steady increase in the demand for water rendered it evident that, at no distant date, the filters would prove incompetent to supply the engines, therefore the author, in conjunction with Mr. G. H. Ogston, Assoc. Inst. C. E., set to work to devise means by which the extraordinary powers of iron might be taken advantage of at a less sacrifice of capital and space than had hitherto been found practicable. The great difficulty lay in the rooted idea that, in practice, a contact of at least three-quarters of an hour was necessary to produce the required effect. The late Professor Way and Mr. Ogston had indeed, shown that with very finely-divided iron, unmixed with gravel, a much shorter contact would suffice; but it was known also that a filter constructed of iron only in such a condition would very soon become clogged, so that no advantage would ultimately be gained. Mr. Ogston in conjunction with the author made numerous experiments with various forms of apparatus devised so as to ensure a rapid passage of water through a mass of material kept open by means of agitation, but the success was not commensurate with the cost of working, so that plan after plan had to be abandoned.

It was at last determined to try a method which had, at the very first, been suggested to the author by Sir Frderick Abel, C. B., F. R. S., Hon. M. Inst. C. E., who in Medlock's time had already had considerable experience in the use of iron for purifying purposes, namely, that of abandoning all attempts at filteration, or the passage of water through large masses of iron in favor of simple agitation of a comparatively small quantity of iron with the water to be treated. A wrought-iron cylinder 4 feet 6 inches in diameter by 6 feet long was accordingly arranged so as to revolve on hollow trunnions, and was fitted up internally with six shelves or ledges, whose office would be to scoop up the charge of iron placed inside, and shower it down continuously admidst the water flowing slowly through. The inlets were at first 2 inches in diameter, the intention being to purify at the rate of 12 gallons per minute, which would give the supposed necessary contact of water with the iron of forty-five minutes. The cylinder was charged with 9 cwt, of iron and set revolving at the rate of one-third turn per minute. The trial showed that vastly too much metal was being taken up by the water; the rate of flow was therefore increased to 30 gallons per minute, when 1.2 grain of iron per gallon was dissolved; and then to 60 gallons, when 0.9 grain was taken up, a quantity still far in excess of what experience at Antwerp showed to be sufficient, namely 0.1 grain per gallon. These experiments were so encouraging, that new trunnions with 4-inch pipes were fitted to the cylinder, and the apparatus was sent to Antwerp, where it was finally put to regular work on the 13th of March, 1884, at the rate of 166 gallons per minute, giving a contact of three and a half minutes only, which proved to be ample sufficient to purify the water. The quantity of spongy iron used during a run in which 6,854,400 gallons were passed through was 0.176 grain per gallon, including coke and other impurities, which form about 30 per cent. of the material, so that in reality about 0.1 grain of pure iron per gallon only was taken up by the water.

The great advantage of using iron in the manner described arises from the circumstances, that the surfaces of the material are always kept clean and in an active condition by rubbing against each other and against the inner surfaces of the cylinder which contains them, as well as by continually falling through the mass of water. It is found that iron in almost any divided form is suitable for the process. The most active agents are cast-iron borings and turnings, on account, no doubt, of the way in which each particle is cracked and fissured; next, probably, comes socalled spong iron; then cast-iron granulated by being poured into water; and lastly, wrought-iron and steel turnings.

The unexpected discovery that the time of contact between the iron and the water could, in practice, be reduced to about one-twelfth of what had always being held necessary, completely changed the aspect of affairs. The author was able to convince the Directors of the Antwerp Water Works Company, by means of the steady and perfect action of the experimental revolver for many months, that the proper course to pursue would be to adopt the system for the whole of the supply, and convert the spongy-iron filters into sand beds. This recommendation was accordingly adopted, and the arrangement indicated on Plate 12 was immediately carried out.

The apparatus consists of three revolving purifiers, together capable of dealing with 1,500 gallons per minute (2,160,000 gallons per day), a small wall engine and line of shafting for driving them, a tank filled with a fine screen for separating coarse impurities, and a purifying house 26 feet by 31 feet by 11 feet 6 inches high, added on to the screw-pump annexe of the main engine-house.

Each purifier consists of a wrought-iron cylinder, 5 feet in diameter by 15 feet maximum length, supported longitudinally on hollow trunnions 10 inches in internal diameter, fitted with stuffing boxes, through which the inlet and outlet pipes pass. The journals formed upon the trunnions, which are 15½ inches in diameter by 5 inches wide, rest in cast-iron blocks fitted into standards, which are secured to the thick concrete floor which covers the whole area of the house; the blocks are each capable of vertical adjustment by means of a wedge and screw, which enables wear to be readily taken up, a precaution rendered necessary to avoid cross-strains on the inlet and outlet pipes.

For scooping up the iron and showering it down through the water, the inside of the cylinder is fitted up with five curved ledges 8 inches deep, and one ledge 6 inches deep, the latter formed of twenty blades 6 inches long, each attached to a ¾ inch shank, which passes through the cylinder, and is secured to it by a nut. The object of this arrangement is to give the means, by placing the blades askew, of throwing the iron back toward the inlet end of the cylinder, if the current of water passing along should tend to make it travel towards the outlet.

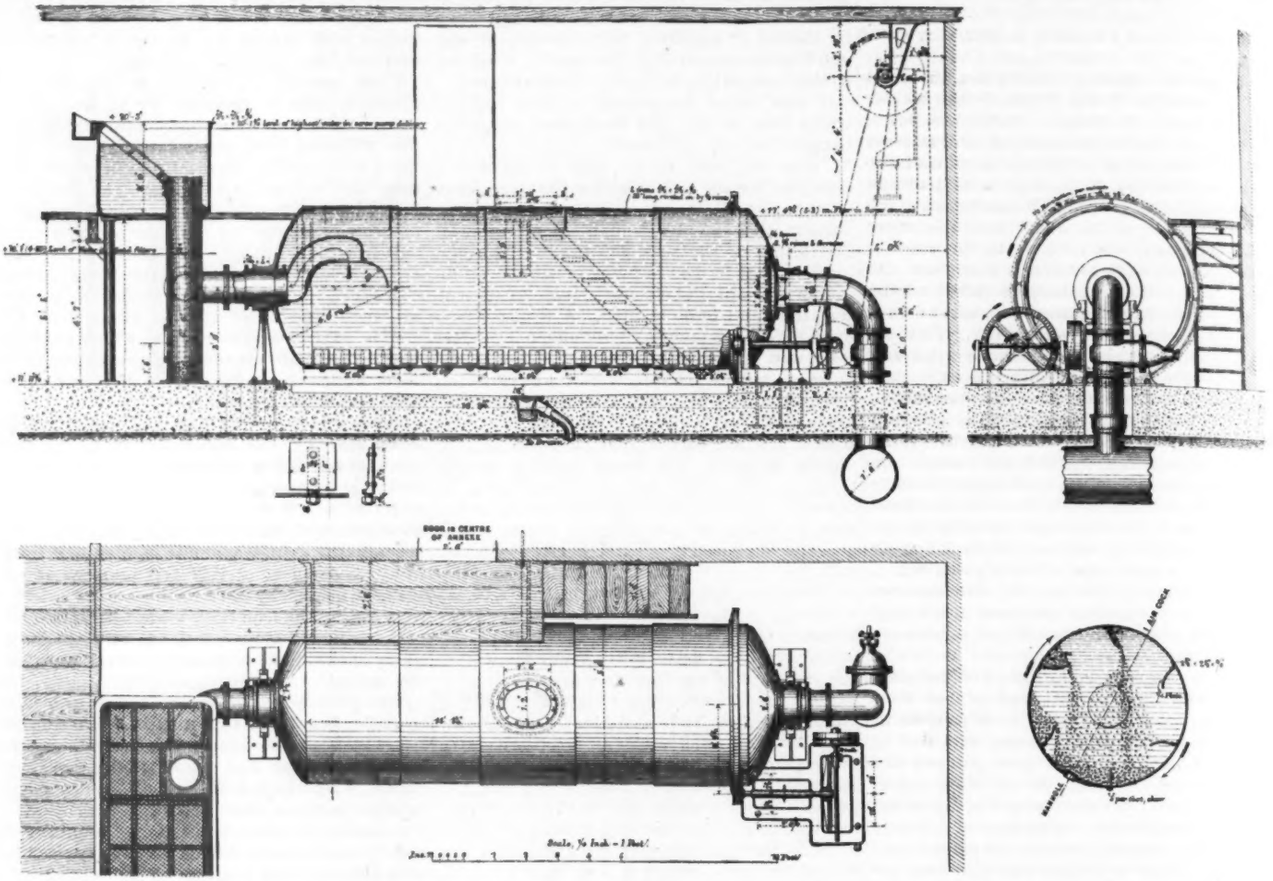
The inlet pipe, where it opens into the cylinder, is covered by a disk of plate-iron, 2 feet 8 inches in diameter, fitted within ¾ inch of the spherical end, so that the entering water is compelled to spread out radially in all directions into a disk ¾ inch thick. The outlet-pipe was, in the experimental revolver, protected by a screen of finely-perforated zinc, for the purpose of preventing the smaller particles of iron being washed out, but it was found to choke so rapidly with moss and other floating impurities, that some different plan had to be devised. The author ascertained, by experiment, that a velocity of 4 inches per second was incompetent to move any but the finest iron in a vertical tube; he accordingly expanded the outlet-pipe inside the cylinder into an inverted bell-mouth, of such diameter that the current upwards would not exceed 4 inches a second. The iron falling over this contrivance slips down its external surface, and is not carried up again by the slow upward current of water. A good deal of trouble was expected from the probability of the iron travelling with the water, but experience has shown that this tendency either does not exist at all, or is of a very feeble nature. The mean velocity of flow through the cylinder is only a little over ¾ inch per second, but this motion is probably very irregular, made up of endless eddies, which effectually prevent the onward motion of the iron. The experimental revolver worked for months without any shifting being observed, but the larger ones above described have shown a slight tendency in the direction expected.

The 10-inch outlet-pipe communicates by means of a bend with an upright pipe of 12-inches diameter, which rises through the bottom of a tank, to which it serves also as a partial support; the lower end rests on the concrete floor of the house, and forms a pocket or trap, fitted with a handhole and door, from which any fine iron which may be carried over is readily removed. In the center of the cylinder is an ordinary manhole, fitted with a cover, in which is a 3-inch brass screw-plug, through which periodical additions to the charge of iron can be readily made.

An air-cock is provided for the purpose of letting out the air when starting, and of getting rid, periodically, of the gases which, with some waters, collect during the running of the apparatus. These gases are so poor in oxygen

*From Selected Papers of the Institution of Civil Engineers.
[1]Minutes of Proceedings Inst. C. E. vol. lxxii p. 24.

PLATE I. PURIFICATION OF WATER BY IRON.



that they instantly extinguish a lighted taper. The three revolvers are placed side by side, and connected, on the inlet side, by 10-inch branches, fitted with sluice-cocks to the 20-inch deli ery main from the screw-pumps. The outlet-pipes all open into a wrought-iron tank, 15 feet long, 3 feet 6 inches wide, and 3 feet deep, fitted with an incline screen, covered with galvanized wire-netting, four meshes to the inch. A shallow trough is formed at the upper end of the screen, for the purpose of receiving and draining the solid matter scraped off from time to time. The object of the screen is to catch the large quantity of moss and other impurities which, especially in summer, form in the inlet pipes to the screw-pumps, and, constantly becoming detached, find their way to the filter beds. It is noteworthy that no such growths take place after the water has been purified. To shut off any of the revolvers from the tank, a lid, fitted with an india-rubber ring, is simply laid over the end of the delivery pipe.

The driving gear consists of an annular spur-ring, secured around one end of each cylinder. Each ring is actuated by a train of gearing working in a self-contained frame, secured to the floor of the house, and driven by a 2½-inch belt from a lay shaft, coupled direct to the crank-shaft of a wall-engine, having a cylinder 6¼ inches in diameter, 9 inches length of stroke, fixed in the screw pump-house. The total weight of each revolver, filled with water and with its charge of 22 cwt. of iron, is 14 tons 6 cwt., and the power necessary to drive it at the rate of one-third of a revolution per minute is 0.4 H. P.

The total capacity of the three revolvers is 15,000,000 gallons per week.

The cost of the establishment in this country, including the house, would be £2,300, while the cost of working, after allowing 5 per cent. deterioration of the building, and 10 per cent. for that of the machinery, together with 5 per cent. interest on the outlay, would be 9s. 9d. per million gallons; the cost in wages and materials alone amounts to 2s. 6d. per million. The total quantity of iron in use is less than 3½ tons, Had the original filter beds been extended so as to do the same work, the weight of iron in them would have been 1,800 tons. The iron dissolved per week in full work will be about 2 cwt.

The revolvers were started on the 12th of March, 1885, and have continued working steadily ever since; the water supplied to the town is reported to be exceptionally bright and clear, so that no doubt need exist as to the success of the new method of purification. The distribution of the iron throughout the length of the cylinders remains singularly even, not only with respect to quantity, but also with reference to the proportions of fine to coarse particles. The author's colleague, Mr. G. H. Ogsten, will deal with the chemical aspect of the process.

"The Purification of Water by Metallic Iron in Mr. Anderson's Revolving Purifiers."

BY GEORGE HENRY OGSTON, F.C.S., F.I.C., ASSOC. INST. C.E.

It is not the object of the present Paper to enter more fully than is absolutely necessary into the chemical reactions involved in the purification of waters by metallic iron, but rather to record the results actually obtained with a considerable number of specimens of water, of various degrees of impurity, on exposing them for a time to the action of iron in a moderately fine state of division.

The author's reasons for desiring to confine himself within these limits, are, first, considerations of space, and then, that the changes which take place under these circumstances have not been thoroughly investigated. It has long been known that important effects were produced, in depriving impure water of its dissolved organic matters, by permitting it to remain in contact with clean iron surfaces for a time. Some thirty years ago, Medlock, in a patent for water purification, described a mode of employing iron turnings for the purpose, which up to a certain point was no doubt successful. It was not, however, largely adopted, probably on account of the impossibility of keeping the surface of the iron free from oxidation, by which its efficiency was soon impaired, and improvements were not introduced in the methods, probably because less attention was paid to the subject then than is now the case. It does not seem to have been seriously pursued so far as the author is aware, until Professor Bischof introduced and patented the use for this purpose of a form of iron now called spongy iron, iron, that is to say, which has undergone incipient fusion only, after its reduction from the ore. The iron so prepared was mixed by Professor Bischof with fine gravel to keep the individual masses apart, and was used as a filter-bed of about 3 feet in thickness. This form of filter has been successfully employed in dealing with the water of the River Nethe, which now supplies the town of Antwerp; and was continued in use there until the new revolving purifier was introduced a short time ago, on increased quantities of water being required. The difficulty experienced in mere filtration through a bed of iron, is in a great measure a financial one. A large space is occupied by the filter-beds, and a great quantity has to be employed of the rather costly material.

A full description of the works at Antwerp has been laid before the Institution by Mr. W. Anderson, M. Inst. C.E.,[1] from which it will be gathered that the great original cost of laying out the large filter-beds and stocking

[1] Minutes of Proceedings Inst. C.E. vol. lxii. p. 24.

them with iron, interposed serious obstacles to the introduction of that system in many situations, and has led to a search for a mode of utilizing the purifying power of metallic iron in which the necessary apparatus would be less costly, occupy less space, and employ less material. Successful experiments in this direction led to the construction of the revolving apparatus invented by Mr. Anderson, which quite fulfills all the required conditions.

About three years ago the late Professor Way and the author, whilst experimenting upon the subject, separately made the observation, that with clean and finely-divided iron the destruction of the organic matter in water, as indicated by the reduction of the so-called albumenoid ammonia, was much more rapid than had hitherto been supposed; and a great number of experiments showed that the extreme effect must have been produced almost instantaneously, since less than half a minute's agitation brought down the albumenoid ammonia to its lowest point. The author may at once say, that it appears never to be absolutely removed; but there is good reason for believing, as the result of experiments to be described further on, that the actively injurious forms of organic matter are destroyed. These observations led to a variety of experiments on the best mode of using pure iron.

Simple filtration through a sufficient quantity was of course amply effective for a time; but, as had been shown, the practical adoption of that system was out of the question, on account of the liability to oxidation and cementation together of the metallic particles remaining without movement. Several forms of moving apparatus were suggested, but the apparatus patented by Mr. Anderson, which embodies also an idea of Sir Frederick Abel, Hon. M. Inst. C. E., overcomes all difficulty in dealing with iron as a purifier.

The main objects in view in the employment of this revolving apparatus were to keep the iron in motion, and to be assured that the whole quantity of water passing through should be in contact with the metal for a sensible time; and further, whatever iron is brought into solution should, with the mechanical impurities, be continually carried away by the stream, to be afterwards separated by filtration through sand filters in the form of ferric oxide, to which it is quickly reduced by exposure to the air. Mr. Anderson has fully described the apparatus in his paper; and it only remains to say, therefore, that the perpetual friction of the particles of iron over one another, whilst the cylinder revolves, and their contact with the shelves, which, during work, lift the iron from the bottom and allow it to fall in a shower through the water, keep the surfaces of the separate grains always bright and active. The form in which iron is most effective, and for several reasons, appears best adapted for use in this apparatus, is the borings of cast iron. In action the particles break up into small fairly-smooth plates, with few irregularities; so that by the rubbing of one grain against another the whole surface is kept clean and bright. Wrought-iron turnings do not expose so much surface in relation to their weight, and much of that surface escapes any rubbing action from the form of the coils. Granulated iron, formed by pouring molten iron into water, as suggested by Sir Frederick Abel, answers well, and when properly prepared, exposed a fairly large surface. The material called spongy iron does not answer so well on account of the roughness of the individual masses. By friction only the prominences are brightened and a good deal of the surface becomes ineffective from the retention in the interstices of the suspended impurities of the water. On the whole, therefore, cast-iron borings are to be preferred.

The experiments now to be mentioned have all been made in the author's laboratory, with a model apparatus constructed by Mr. Anderson, and used in every way as the large forms (Plate 12) would be used; with the same rate of flow, and the same quantity of iron in relation to the water to be purified, differing only, in that the experiments were necessarily interrupted from day to day, instead of being continuous, as in practical work they would be.

The capacity of the model revolver is 3½ lbs., and this quantity of water passes through in from three to five minutes.

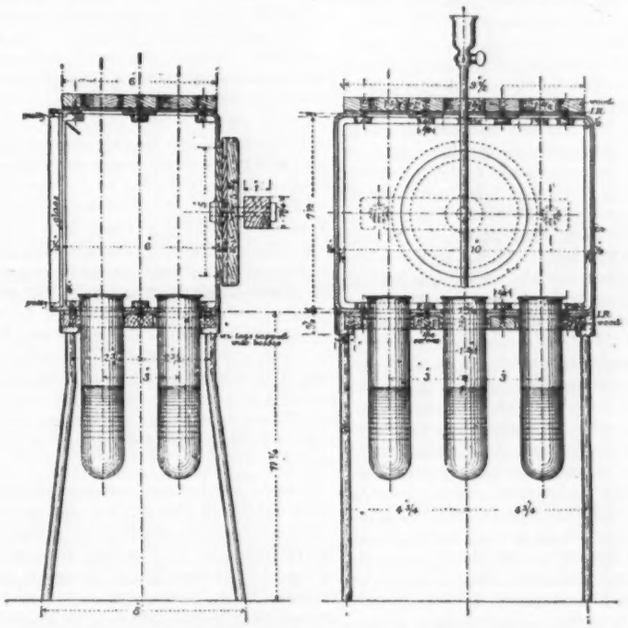
It has not up to this time been possible to examine a large number of waters, but those that have been dealt with present a considerable variety in composition, and are probably fairly representative of waters commonly met with. The first obvious effect of the iron upon an impure water is to deprive it of any color it may have. A minute quantity of the iron is immediately dissolved, probably as ferrous carbonate, and almost immediately thrown down as ferrous oxide. After a short exposure this becomes ferric oxide, which is deposited and separated with great ease by filtration through a very shallow layer of sand. The author has found 4 inches of sand generally sufficient to produce a perfectly bright sample at a rapid rate of filtration; the time required for subsidence and oxidation before filtration is from five to six hours. The effect of this treatment upon the waters that have been examined, is to deprive them entirely, as seen through a tube 2 feet long, of the color due to the presence of dissolved organic matter; and this removal of color is accompanied by the breaking up of certain nitrogenous compounds, as shown in the analytical results, by a great reduction in amount of the albumenoid ammonia. The author has chosen this mode of expressing results because the method of analysis by which they are obtained permits the examination of a large number of samples and indicates, in his opinion, the degree of impurity in ordinary waters very completely. It has been said that the action of the iron is almost instantaneous; and in some cases it is astonishingly rapid, whilst with highly polluted waters a distinctly longer time is necessary for the full effect to be produced, so that from eight to ten minutes may be required in extreme cases, in others a third of that being sufficient. It is proved that, whilst much of the organic matter is affected by the iron, a certain proportion of it either resists its influence altogether, or undergoes only partial change; this proportion is generally represented by from one-third to one-half of the quantity that would have appeared under the head of "Albumenoid Ammonia," but the waters are in all cases deprived of the color that impure water possesses, and are reduced to the pale green tint of pure water.

The following table shows the amount of albumenoid ammonia in a million parts, in several waters that have been analysed, and includes samples varying greatly in composition, and includes samples varying greatly in the original quantity of organic nitrogen.

Water from	Before Purification in Revolver	After Purification in Revolver
Zurich	0.020	0.010
Ostende	0.140	0.080
Laeken	0.185	0.060
Thames	0.150	0.060
Malines	0.260	0.060
Antwerp	0.200	0.080
Northwitch	0.110	0.040
Itchen	0.080	0.040
New River	0.030	0.015
Hertford sewerage	0.330	0.080

Why a certain proportion of these nitrogenous compounds resists the action of the iron, whilst the larger portion is broken up, is not clear, but the author hopes at a future time to be able to acquire some information upon these points. It is plain that there are two classes of compounds, one of which only gives up its nitrogen readily, either as free nitrogen, or in the form of nitric acid, or of ammonia, and it would be of the greatest importance to show, if possible, that the more stable forms are less to be dreaded in a soluble water than those which are more easily decomposed. To fix upon any particular quantity of organic matter as it is now determined, or to describe the special form, that can be positively said to be injurious to health, is beyond the powers of the chemist; but if a water contains distinct evidence of animal pollution, it can be said there is danger that the source whence the pollution is derived may supply the poisonous germs of disease, whenever sickness occurs within the drainage area of that district.

The time indeed seems to be near when, by by the aid of the physiologist and the microscopist, it may be possible to say what special danger is to be feared from a polluted water. In the case of one of the samples on the list, viz., the Zurich water, this is said to have been done. It contains, as will be seen, less albumenoid ammonia than any other sample, and less indeed than it is usual to find in the best waters; but the report of a German physiologist shows that typhoid fever had occurred in the district supplied with water from this source; that he had found in it a form of bacterium which, when multiplied by pure cultivation, induced characteristic symptoms



DETAILS OF STERILIZED CHAMBER.

in the lower animals. He was thus able to recognize a dangerous water, which by analysis appeared to be exceptionally pure.

With the knowledge of what had been done by Dr. Frankland, Professor Bischof, and the late Mr. Hatton in regard to the proof of the destructive effect of spongy iron upon the bacteria existing in water, the author instituted some experiments upon the waters which had been treated in the revolving purifier, to ascertain if these microscopic organisms were affected by the short exposure to the action of iron as was sufficient to effect the changes already described. The test was to be the relative power of the water, before and after treatment, to set up putrefactive fermentation in a properly prepared meat-extract.

Whatever views may be held as to the germ theory of the propagation of disease, it is certain that decomposition of animal matter quickly occurs on its exposure at common temperatures to moisture and ordinary air, from which the usual dust has not been separated; but that, if the air has been deprived of dust and the organisms inseparable from it, by filtration or other effectual means, organic substances may be freely exposed to it without undergoing change. So with water, if it be filtered throught a medium sufficiently fine in texture to retain the microbes—biscuit porcelain, for instance—or be sterilized by repeated boiling, it will not induce decomposition in meat-extracts rendered specially sensitive even, and may be considered to be preservative in its effect. On the other hand, as all natural waters contain a greater or less number of the organisms that cause, or at all events accompany, fermentation or putrefactive change, either derived from the air, or more directly from drainage sources, it will be of great importance if it can be shown that they can be got rid of, or rendered innocuous, by an easily applied purifying process. Although the microbes that induce decomposition in the test meat-extracts are not neces sarily, or even probably, identical with those that occasion actual disease, it is not unfair to suppose that the agency that destroys or renders inert one class of bacteria, will be fatal to all classes; and that if a polluted water, after being submitted to this system of purification, is incapable of inducing putrefaction, originally present, all organisms have been destroyed, and that the germs of special disease acquired from drainage sources have therefore been got rid of.

The experiments, made by the author upon waters after being in contact with metallic iron, lead him strongly to the belief that this treatment completely destroys the microbes. In most of the experiments the water, after passing through the revolver, was incapable of setting up fermentation in either hay infusion or meat-extract, although occasional failures in the experiments occurred, especially at first. These were mostly to be traced to the difficulties of excluding access of air during the operations, and to defects in the apparatus employed for the demonstration. Several forms of apparatus were used, but the two ultimately preferred by the author may be described. The first of these, shown in the Plate, provided by Mr. Anderson, resembled almost exactly the sterilizing boxes employed by Professor Tyndall, and consisted of a box, in the first place made of teak wood, and later on of thin cast iron in one casting, raised on four legs about 12 inches from the table. The front was glazed, and made perfectly air-tight with cement; in the back there was an aperture 4½ inches in diameter, closed by a disk capable of being pressed by a cross-piece and screws tightly against an india-rubber washer, this aperture being necessary for the introduction of the test-tubes containing the meat-extract, etc. The top and bottom of the box were pierced with six holes 1½ inch in diameter, and covered with sheets of vulcanized india-rubber ⅛ inch thick; this was firmly held by covers of wood ½ inch thick, screwed to the top and bottom of the box, and having in them holes corresponding with those in the box itself. From the bottom sheet of rubber desks were cut out less than one inch in diameter, so that when test-tubes of rather more than one inch across were forced through the apertures thus made, they were secured perfectly against access of air by the contraction of the india-rubber. Before being introduced the tubes were filled with meat-extract or hay infusion to about one-half of their capacity. The box was now closed by screwing on the cover at the back, and the solution in each of the tubes boiled for six or seven minutes gently. It was then allowed to rest for three days. When it was known by experience that the contained air would have deposited all its dust, with whatever germs or spores might be associated with it, and would be therefore incapable of inducing fermentation of any kind, the solutions were again boiled very gently, to destroy whatever might have fallen directly into the tubes, and the arrangement was complete. Eight or ten of these boxes were available at any time for the various trials.

The author should have said that at one upper curve of the box a small hole was made, into which was fitted a quill glass tube, bent two or three times, and stopped at the extremity with cotton-wool. This allowed the escape or entrance of air during change of temperature and barometric pressure without the introduction of dust.

The water to be tested was received direct from the exit tube of the model revolver in a test-tube sterilized by being baked in an oven, reserved for the purpose, at a temperature of 320° Fahrenheit for five hours. The tube was stopped by cotton-wool, treated in the same way, and the water to be tested was withdrawn by forcing through the wool a pipette mode of very fine tubing drawn to a point, (at the upper end this pipette was also stopped with sterilizing wool), and by means of an india-rubber tube, sucking up about 1 cubic centimetre.

A stout pin being now pushed through the india rubber in the top of one of the boxes, the hole so made closing up immediately by the contraction of the inda rubber, the point of the pipette was forced through, and, when sufficiently far, directed to one of the test tubes, any of them being able to be reached by a tube 10 or 12 inches long, owing to the flexibility of the material. Upon removing the pressure of the fingers upon the tubing attached to the pipette, the water passes in, and the air taking its place is filtered through the cotton wool stopper, and so deprived of its dust.

In a case of considerable number of the experiment, the pipette was expanded in its upper part into a tube 1 inch in diameter, and 6 inches long, which was converted into a sand filter, so as more nearly to represent what occurs in practice, it being necessary to filter water after the iron treatment, to separate the deposited oxide of iron, etc. After filling in the sand to form the filter, the whole was sterilized in the usual way by baking for five hours. Upon the introduction into the apparatus of the water to be tested by the mode described, means were taken to maintain the temperature at about 80° Fahrenheit, and almost invariably at the end of two days a corresponding quantity of the water which had not been purified, had rendered its tube of meat extract cloudy from the swarms of bacteria produced, whilst, if the experiment was successful, no cloudiness either in the tubes to which no addition has been made, or in those to which purified water had been added, was perceived.

A second, and more simple, arrangement has been employed with success in many instances. It consists only of a flat glass plate 4 inches square, and a hemispherical cover accurately ground on its edges, 3½ inches in diameter. The plate is supported upon a large sheet of thick glass, capable of holding six or eight of the smaller ones, and by screws adjustable so as to be made exactly level. This precaution is necessary, because the author prefers to use a meat-extract, which, when cold, is still fluid, so that any water added to it may diffuse itself throughout the whole, without its being necessary to expose it to air long enough to mix them together by stirring, and if the arrangement is kept quite level, 3 to 4 cubic centimeters of solution may be placed in the center of the plate, without danger of its running out to the edges. The plates and covers, being sterilized, were placed upon the larger sheet to cool; 4 cubic centimeters of the meat extract were withdrawn from the stock preserved in a flask, by pushing a pipette through the cotton-wool stopper, and depoisited in the center of the plate, the cover being momentarily removed for the purpose. By another pipette, ½ cubic centimetre of the water to be tested was added to the extract with the same precautions, and immediately covered up. Besides the purified water, there was always prepared at the same time for comparison, the water in its original condition, and some of the meat extract without addition. The meat extract employed by the author, made according to the direction of Dr. Koch, was of beef, and neutralized, to which was added gelatine. It was, after boiling, filtered, so as to be absolutely bright, and the strength was arranged that at a temperature of 60° Fahrenheit it was just fluid.

The waters upon which most of the experiments have been made, to which the author desires to draw attention, have been, water from the Thames, as being easily obtainable, and water from Laeken (Belgium), an impure water, of which the author had a quantity at his disposal. In the case of the Thames water, five experiments out of seven in which it was passed through the revolver were successful, the water being completely sterilized, whilst two failed. In the Laeken water, which is taken from a stream supplying the lake in the park of His Majesty the King of the Belgians, three experiments succeeded, and one experiment failed. With the Zurich water, remarkable as being almost free from organic matter, and supposed to have occasioned much seaside, the only experiment made showed that in its orginal condition it rapidly developed bacteria in the meat extract; but that it was completely sterilized after purification. With water from Northwitch, in two experiments, the sterilizing effect was produced, and in one case it failed. Throughout the trials, in about four cases out of five, the mode of treating the waters that has been described has completely sterilized them; it must be understood that in every case the water not so treated was active in determining the decomposition of the meat extracts under similar circumstances, and that comparative trials were always made with the samples in the two conditions side by side. In spite of all precaution, it is very difficult to exclude the momentarily access of air during the various transferences of the water and meat extract from the revolver to the testing glasses, and the author attributes most of the failures to this cause. It seems that if in the great majority of cases the organisms are destroyed, the effectiveness of the agent is established, since it is not at all likely to be capricious in its action. Considering these facts, and considering also the great reduction effected in organic nitrogen, and the removal of color from impure waters, there appears to be reason for the belief that an economical and efficient method of water purification has been found in the mode of treating by metallic iron; indeed, it would seem that impure waters purified by means of iron will prove safer for

dietetic purposes than even good deep well or spring water, because after treatment the water can be preserved from contamination by means of covered reservoirs, or in the mains and pipes, whereas wells and springs, as numerous cases prove, may become dangerously contaminated.

The only specimen of true sewage the author has been able at present to deal with in this way is that from Hertford, taken from the Manifold ditch below the town. The result of experiments with this liquid, so far as they are carried out, was very satisfactorily. The albumenoid ammonia was always reduced to to 0.08 in a million parts, and of the two experiments that were able to be made with it, after purification, one was completely successful in destroying all organisms. The second experiment, which exhausted the supply of sewage, failed from an accident to the apparatus. In the case of a water so highly polluted as this, no doubt a comparatively prolonged contact with the iron is necessary, and with this particular sample fifteen minutes were allowed.

Nitro-Gelatine.

We referred, says the *United States Army and Navy Journal*, to the Nordenfelt experiments with gelatine for the bursting charges of armor-piercing shell in our issue of last week. We have since learned a few details of the work recently done in this direction by the Naval Ordinance Bureau, the results of which are considered as very promising. The explosive used at Annapolis is gun-cotton, the liability to accident from shock being eliminated by an excessive percentage of moisture. The explosive combustion of the bursting charge is obtained at a desired moment by means of the gun-powder fuse developed at the naval proving grounds, referred to in the last report of the Secretary of the Navy. Enumerating the experiments briefly in the order of their occurrence, spherical cast-iron shells of 15-inch caliber, and 8-inch muzzle-loading rifle common shells, containing charges of from 5 pounds to 7 pounds of gun-cotton, carrying 30, 40 and 50 per cent. of water, were successfully detonated in an explosion chamber. A target was then constructed of six 1-inch wrought-iron plates, backed by 10 inches of oak, against which were fired steel armor-piercing projectiles charged with gun-powder, and others with gun-cotton, carrying 50 per cent. of moisture, from the Hotchkiss 6-pounder rapid-firing gun, at a velocity of 1900 f. s. The gunpowder charged shells—which were unfused, the intention being to develope explosion by the heat of impact—burst at a mean penetration of point of 8 inches. The gun-cotton shells—likewise unfused—with 50 per cent. of water, reached a point penetration of 11 inches and did not explode. Explosion with 9 inches penetration occurred with gun-cotton bursting charges containing 40 per cent. of water. Lastly, gun-cotton shells containing 50 per cent. of water provided with the exploder and a "delayed action" percussion fuse were fired through 3 inches of wrought iron, and reached a penetration of 5 feet into dry sand before explosion. These interesting results would seem to indicate that for work against armor a notably greater penetration may be obtained with wet gun-cotton bursting charges, with the attendant enhanced destructive effect than with gun-powder. It is said the Naval Bureau has directed experiments in this direction to be made with a higher power 6-inch gun against steel plating of from 5 to 10 inches thickness, the results of which cannot fail to be of great interest to ordnance officers.

ENGINEERING NEWS Three months for One Dollar.

OUR MATHEMATICAL COLUMN.

IF A six-sided figure be inscribed in a circle, and each pair of opposite sides be produced until they meet, the three points of intersection will line in one straight line. This theorem, which is called Pascal's hexagram, is also true of hexagons inscribed in an ellipse, parabola, or hyperbola.

ASTROLOGERS divided the heavens into twelve compartments, which they called houses. The four cardinal points were the most important of these houses. Planets when found in these angles were thought to be more potent for good or evil than in other houses. The most powerful house was the south, or when a star was on the meridian above the earth with a square aspect.

THE magic square diversion is not an ancient one. The earliest known magic squares appear in a manuscript which was the work of Emanuel Moschopulus, a Greek of the sixteenth century, and which was translated into Latin by the mathematician De la Hire, and read by him before the Academy in 1691. Later the principle was extended to the magic circle, the magic cube, the magic sphere, and finally to the magic cyclovolute. The discussion of these is often abstruse and generally time-consuming, but it may be mentioned, that one of the most ingenious—the magic circle—was devised by the great teacher of economy of time and money, Benjamin Franklin.

IT HAS been a favorite object of investigation among mathematicians to determine the probabilities of events and the degree of confidence that we may place in testimony of a historical or traditionary character. The mention of a number which is found to be indisputably accurate, may often afford strong evidence of the reliability of a historian. For instance, Diocloros Siculus gives forty-two as the number of persons which sat in judgment on the merits of the deceased at an Egyptian funeral; and in ancient rolls of papyrus lately discovered, it is observed that forty-two persons are representated as assisting Osiris at a similar ceremony. Mathematicians have estimated from this that we might venture to wager even fifty against one that Diodorus was a well-informed and faithful historian, and that the rolls of papyrus have been truly interpreted.

IT IS unfortunate that the beautiful metric system of weights and measures should be burdened with such an awkward nomenclature. We have microns, millimeters, centimetres, meters, dekometers, hektometers and kilometers—seven long names to express a few simple ideas. It is believed that this oppressive nomenclature is one of the principal reasons why the system has made so little progress in this country. The Germans, it appears, were wise enough to recognize this difficulty, and when legalizing the new system and the new names, they provided that the old familiar appellations might be employed. Centimeter, for instance, might be called *new-zoll*, (new inch), among the peasantry, while the learned could employ either that term or the French one. The fact is that people will not lightly tolerate a change which affects their language, and this tendency is particularly strong among those who have little to do with reading and writing.

A right cone is one-hundred feet high and the diameter of its base is five feet. Around it is wound a rope one-half inch in thickness which forms a spiral helix. It is required to find, first the length of the rope; and second the distance a man would travel in unwinding it, neglecting in the latter case its slant or inclination.

Let h be the height of the cone, $2r$ the diameter of its base, and t the diameter of the rope. Then the number of winds of the rope is

$$\frac{\sqrt{r^2 + h^2}}{t}$$

and the length of the rope is

$$\frac{\pi r \sqrt{r^2 + h^2}}{t}$$

By inserting the numerical values for r, h and t the length of the rope is found to be 18,850 feet.

The length of the involute described by the end of the rope in unwinding it, when the man begins at the base is

$$\frac{4\pi^2 r(h^2 + r^2) - 3t^2 r}{2t^2}$$

and inserting in this the given numerical values the distance is found to be 189,584,753 feet. If the man begins at the top to unwind, the length of the involute is expressed by a somewhat different formula, and it would not be practicable to omit the slant of the rope.

PROBLEM 16. (Proposed by Prof. J. V. Hazen, Dartmouth College, Hanover, N. H.) An engineer being in want of a beam 20 feet long capable of sustaining nine tons uniformly distributed with a factor of safety of ten when supported at its ends, sent to a timber lot of yellow pine for a log from which to cut the beam; required the diameter of the log needed. The log is to be the smallest one necessary and is not to be used in its cylindrical form.

PROBLEM 17. Let A and B be two points whose elevations above a given bench mark M are to be determined, the distances MA, MB and AB being nearly equal. Let a level be set up between M and A and readings be taken which show A to be 12 inches higher than M. Then let it be moved to a point between B and M and readings be taken which show B to be 16 inches higher than M. Lastly let it be set between A and B and readings taken showing B to be 5 inches above A. Required the most probable elevations of A and B above the bench mark M.

Steel Castings.

The subject of steel castings for locomotives was discussed at the recent master mechanics' convention, and the *American Machinist* has been investigating the subject further. Inquiry was made of a number of master mechanics who are using steel castings made by the Chester Steel Castings Company and other concerns about their strength, comparative cost and wearing qualities.

The Chicago & Northwestern is using steel castings largely, and uses them entirely for cross-heads. Mr. Felton considers that the increased safety and durability more than compensate for the extra cost. He has in some cases, substituted steel castings for forging of irregular shape—receiving as good results at less cost.

The Chicago, Milwaukee & St. Paul uses steel castings for locomotive cross-heads, levers, etc. A test showed a tensile strength of 86,000 pounds for cast steel, 60,000 pounds for Ulster iron and 40,000 pounds for common wrought iron; elongation of steel when it broke, 1-32 inch, Ulster iron ⅛ inch, wrought iron ⅛ inch. The steel tested was made by the Solid Steel Company, of Alliance, O.

The Louisville & Nashville has had steel cross-heads on ten engines about five years; and on eight engines about four years. They are as good as ever, and experience is highly favorable.

The Pennsylvania R. R., has used steel castings principally for driving-boxes. Strength and wearing qualities good, but cost greater than iron castings.

The Chicago, Rock Island & Pacific has used steel cross-heads and rockers satisfactorily and will try steel link-hangers and driving boxes. Find steel castings a good substitute for cast iron wherever unusual strength is required; and for expensive and difficult forgings. Cast steel does not wear well against wrought iron or steel; but does against cast iron or brass. Use brass or phosphor-bronze gibs on cross-heads.

The Boston & Albany prefer steel castings for both economy and strength. Wearing surfaces have to be protected to prevent trouble from cutting.

The New York, Pennsylvania & Ohio has cast steel cross-heads on 140 locomotives; at a cost of 6 cents per pound against 2 cents for cast iron. Has not had a failure. Think pistons and driving boxes should also be made of steel.

The Milwaukee & Northern uses steel cross-heads with satisfaction. Has had disastrous consequences from the breaking of iron cross-heads.

The New York, Susquehanna & Western has not used steel castings. Has used cross-heads made of charcoal iron and 20 per cent. low grade steel, which are stronger but do not wear better than cast iron.

Steel cross-heads are used with good results also by the Terre Haute & Indianapolis; Grand Trunk; Lake Shore & Michigan Southern; Kansas City, Ft. Scott & Gulf; Delaware, Lackawanna & Western; New York, Lake Erie & Western; Buffalo, New York & Philadelphia; Chicago & Eastern Illinois, etc. A number of other roads are using them but do not feel warranted in expressing an opinion based upon their limited experience. The Grand Trunk and Burlington & La Moille use cast steel Miller hooks and find that they wear well. Cast steel rockers are also used by the Terre Haute & Indianapolis, Lake Shore & Michigan Southern, Illinois Central, and Cincinnati, Washington & Baltimore.

It seems to be the general opinion that cast steel is the best material for many parts of the locomotive, both for strength and durability; and that its use will continue to grow, if a satisfactorily quality of metal can be obtained.

Engineering News

AND

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WE have had several enquiries from correspondents as to the date of the explosion at Flood Rock, at the Hell Gate entrance to the East River. The exact date of this important event is not yet fixed nor can it be for some time to come. Current rumor puts it between the 1st and 15th of October next.

The government will necessarily give full notice of the day and hour so that shipping may keep out of the way, and this notice will be duly announced in the papers of the country. We will give an account of the undertaking in our next issue.

LATE reports concerning the South Penna. R. R. seem to indicate that the work is to be completed by its new owner, the Pennsylvania R. R., but it is to be done very leisurely. This appears to be the most sensible method of disposing of the partly completed road; the local traffic is worth considerable, and perhaps the purchaser has an eye to the utilization of this route in connection with the extension of its lines into Kentucky, of which we lately noticed some vague rumors in the daily press.

In regard to the proposed action of the Attorney General of Penna., the able lawyers in the employ of the Penna. Co., have doubtless studied all the bearings of the case as carefully as Mr. Cassidy himself. In any event it is now reported that this company will assume all the responsibility of the affair and argue it out, if the proposed interference amounts to anything more than a political manouvre.

WE were in error last week in stating that the History of Boston Main Drainage, by E. C. Clarke, was for sale at $1.25. The price is $1.50, postage paid, and an exceedingly cheap volume it is at that price. It is published by the City of Boston without profit, and orders *must* be directed to the City Messenger, City Hall, Boston, Mass. It is not for sale by dealers.

A MR. MCINTYRE, late superintendent of construction of the English warships, *Swiftsure*, *Triumph* and *Terror*, has patented a new type of armor-plate. The design includes the complete protection, at the water line, of warships by a >-shaped armor-belt.

The two plates forming the belt would have a horizontal projection of 5 feet, and a vertical height of 10 feet, or each plate would be on an angle of 45°. The upper plate, in a design submitted, would be 8 inches thick by 7 feet wide, the lower plate, 5 inches thick by 7 feet wide, and below all is a vertical plate 9 inches thick by 2 feet wide. The apex of the ">" would be at the water-line.

Mr. McIntyre calculates that the resisting power to shot is doubled by the inclination of the plates, and that the saving in weight as over vertical plate of equal resistance is as 7 pounds is to 10 pounds. Among the other advantages it makes ramming by an enemy's ship dangerous work to the attacking party, the overhang forms a good point of attachment for torpedo netting, and, by adding to the ship's beam at the water line, it will materially steady the vessel in rough weather.

The expedient is simple and seems effective, but the idea is practically antidated by the rams *Vindicator* and *Avenger*, built about 1864 for service in the Mississippi Squadron during our own late war, where the ">" however, was solidly packed with wood.

American Locomotives in New Zealand.

Our London contemporary, *The Contract Journal*, finds fault with a late article in the *National Car Builder*, on the supply of American locomotives to the English Colony of New Zealand.

The *Car Builder* stated that engines ordered from England, to be built upon American plans, were rejected because their excessive weights, above that contracted for, would have required all the bridges on the line to be strengthened, and the order was ultimately filled from Philadelphia.

The *Journal* says that "had the bridges been stronger in the first place, the locomotives, as constructed in England, would have doubtless been accepted." We fear that our English friend only advances one more argument in favor of the American type of construction; the bridges were without doubt strong enough for the traffic intended, and we can see little economy, or less common sense, in adding to their cost, and that of the line generally, simply to accommodate a heavy, English-made locomotive because it was English. The American made engines had been tested in the Colony, and, according to Sir Julius Vogel, the Colonial Treasurer had given exceptionally good service. They wanted more like them, and patriotically ordered them made in England; but, as the *Contract Journal* says, the shops there were not fitted with plant adapted to their construction as per specification, and the order came to America, where it should have gone at first.

As the *Journal* remarks, an American company would have found as much difficulty in filling a small order for locomotives of an English type; but the lesson taught nevertheless to the English maker is, that the American locomotive is better adapted to colonial railways, than the engine that certainly does good service in England itself, under widely differing circumstances. Controlling conditions first necessitated a certain economy in railroad construction and railroad plant in America, and a wide departure from the earlier English practice; but experience, native inventive talent, good judgment and strong common sense have now combined to make our bridges, locomotives, and transportation facilities generally unsurpassed in the world, for the most efficient work at the least expenditure of cash. The English colonies are situated more like ourselves than like the tight little island of England; and if they can't get what they want at home, they will come to America for it, as they do for their axes, saws, and their hardware. As the *Journal* sensibly remarks, the one great essential required in English trade, is greater flexibility; and that is just the strong feature in the American manufacturer; he will make anything to fit any condition of affairs, regardless of traditions; and if we make what people want, England must expect us to sell our goods.

Prospective Engineering Contracts in England.

According to a Parliamentary paper containing the number of private bills passed in the session of Parliament just ended, there is a prospect for considerable contracting work in England.

Of 237 bills before the Committee, 161 bills passed, and of this number 70 are railway projects, 45 of them including the construction of 230 miles of new railway and other work at an estimated cost of $67,005.000. Twelve of the authorized bills are for the building of 114 miles of railway just incorporated.

The largest single outlays are, for the London and Northwestern Co., $6,650,000; for the Great Eastern, $5,000,000, and same amount for the South Eastern Co., and a number of other schemes ranging from $2,000,000 to $4,000,000 in cost.

Among the other bills are, 12 tramways; 20 gas and water bills; 10 in connection with docks, harbors and rivers, and 14 town improvement bills. The most important bill passed was the Manchester Ship Canal bill, involving the construction of a canal 36 miles long at an ultimate estimated cost of $50,000,000.

The Foundations Under the Campanile of St. Mark's, Venice.

Mr. C. H. Blackwell contributes to the last number of the *American Architect* an exceedingly interesting article upon a recent personal examination made into the foundations under the campanile of St. Mark's in Venice, from which we make the following abstract:

According to the best available authority, the foundations of the campanile date back to 888, though several centuries elapsed before the structure rose above the surface of the ground. It must have been finished before 1329, for in that year there is a record of the restoration of its top. It seems to have originally been surmounted by an open wooden loggia with a low pyrimidal roof, which was frequently destroyed by fire and as often restored in some form of timber. In 1550, the present stone terminal features were built.

The entire height of the campanile, from the upper base course to the auriole of the angel's head which caps it, is 321.15 feet; the building is not perfectly plumb, it inclines slightly to the north-east. The horizontal dimensions at the base are 42.3 feet by 43.46 feet.

The most interesting features connected with this ancient structure lie under-ground, as the author well remarks. Mr. Blackwell figures the entire weight of the structure at 13,000 tons, in round numbers, and the distributed load on the piling at about 6 tons per square foot. Taking into consideration the treacherous nature of the soil upon which the building stands and its area, it is one of the heaviest isolated structures in the world, and subjects the soil to a pressure that would well startle modern builders. The islands upon which Venice is built are composed principally of a mucky, alluvial clay, the upper layers looking like black mud; deeper down the clay becomes quite firm but never as stiff as our blue clay. Under this clay stratum, which varies in thickness from a few inches to a hundred feet, is a bed of sand, full of water, and with practically no hard bottom.

These being the conditions, Mr. Blackwell sought to know more about the foundations, and after much red-tape experience and strong endorsement, he obtained the requisite permission to start a hole at the corner of the campanile, and he thus records his results, but in fuller detail as to architectural features than we give them.

The pit uncovered about 3½ feet face of the foundation. The foundation was found to be 15.67 feet deep from the pavement to the top of the timber; the material used was roughly dressed stone, being hard lime stone, red Verona marble, trachite and the lowest course of all was green porphyry; some of this stone had evidently been used in previous structures, it being probably cheaper to rob an ancient building than transport the material from the mainland. The masonry was all laid in lime mortar of rather a poor quality, it was much disintegrated, due probably to the action of the sea-water which rises in this soil nearly to the level of the pavement; the work uncovered was well coursed with surfaces in contact more or less carefully dressed.

The foundation masonry rested directly upon a grillage of crossed timbers, each of the two layers being 4.72 in. thick; this grillage rested directly upon the heads of the piles. The piles are close together and appeared to average 9½ inches in diameter at the head, but it was impossible to ascertain how deep they were driven. The timber in the piles was oak and they were as sound and tough as sap-wood, the grillage was made of larch wood, similar to our yellow or hard pine. This grillage timber was so soaked with water and blackened by age that it was difficult to determine much about it, the outside could be broken off by the hand, but the inside was quite firm, especially so when we consider that it has been soaking for one thousand years, as the water circulates freely through these timbers. Around the outside of the base was found an extra row of piles without any load upon them at all; as the tops of these piles were exactly on a level with those under the mass, the tipping mentioned can not be ascribed to any inequality in the settlement of the piles, as the test pit was sunk on the low side. The author ascribes the trouble rather to a general movement in the earth, such as has elsewhere been observed in Venice and in the lower valley of the Po, where Roman pavements have been unearthed at a depth of as much as 25 feet below the present surface.

The superstructure of the tower is brick, and the bricks used are very large, some of them measuring 17.6 × 12. × 3. inches. In referring to the load per square foot upon these foundations, the author suggests that the more probable function of the piles is to compact the mass of clay, the latter really carrying the load.

PERSONAL.

ROBT. GILLHAM, Chief Engineer of the Kansas City Cable Railway has been spending several weeks at Asbury Park, N. J. He returned to Kansas City this week.

CAPTAIN JAMES B. EADS, will leave in a few days in compliance with an invitation from the Emperor of Brazil to examine and report on the harbor of Rio Grande de Sul, the most southern port of the Empire of Brazil.

AZEL STORRS LYMAN, the inventor, who died in Brooklyn, Aug. 26, was born in Potsdam, N. Y., on Jan. 26, 1815, and was of the eighth generation of descendents of Richard Lyman, who came to New England in 1629. He was educated at the Illinois University, and began to study for the ministry, which he was compelled to relinquish on account of incurable deafness. For some years past he has devoted himself to inventions and the procuring of patents. He was the inventor of the multi-charge gun.

W. COURTLAND D. HOWELL died Aug. 24, at his residence in Philadelphia, at the age of 71. He was one of the engineers on the construction of the Altoona section of the Pennsylvania R. R., and was a contemporary of Edward Miller and Strickland Kneass. In later years he was connected with the Farmer's and Mechanics National Bank of Philadelphia.

NATHAN STEPHENS, a well known contractor and long resident of Brooklyn died suddenly Aug. 27, at Summit Mountain, N. Y.

Mr. Stephens was born at Coeymans on the Hudson, eighty-one years ago. He was engaged in many very important paving contracts in his earlier career. He had a large contract under way for paving New Orleans when the war broke out. With Mr. Baird his partner, he took large contracts in different cities. It is said the firm built more water works than any other in this country, Mr. Stephens fought the Nassau Water Works, which had a dispute with the city of Brooklyn, and the result was that he saved Brooklyn some three millions of dollars. The Nicholson Pavement Company was also opposed by him. He claimed that the corporation was not complying with a contract made with the city, and with his own money opposed them until he gained his point. The trouble with the corporation was that they insisted on paving Lafayette avenue with close joint instead of with joint blocks. For his efforts the city appointed him Inspector of Pavements.

CORRESPONDENCE.

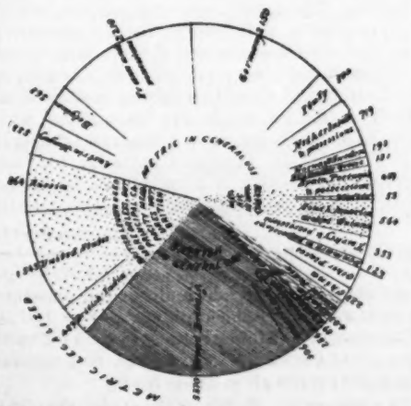
Why the English Cling to Old Weights and Measures.

THIRD PAPER.

Communicated to ENGINEERING NEWS.

The argument that John Bull is too big a fellow to learn from his neighbors, appears in the following extract from the remarks of Mr. De Salis in the recent discussion in the Institution of Civil Engineers:

"The British sway extended over one-fifth of the habitable globe, while the area of metric countries was only about one thirty-fifth. The British Empire included a population of 310 millions, the United States 50 millions, and the metric countries about 200 millions. The British imports and exports for 1883, to the British possessions, amounted to £188,000,000, to the United States, £135,000,000, to various other places £142,000,000-



making a total of £465,000,000; the amount to the metric countries was £266,000,000. Therefore, as far as size went, the balance was entirely on the side of the present measures."

Of the 310 millions population, 254 millions live in British India, where they now weigh and measure with the *ser* and *maund* and *cubit*, and where a law has been passed providing for the introduction of metric weight and capacity measure.

Previously to about twenty years ago there was represented on charts of the Atlantic Ocean, some 300 miles from the Irish coast, an island of Brazil, which the progress of geographical knowledge has shown to be fabulous. It was accordingly obliterated from the map about 1865. It was popularly supposed, however, that Don Pedro's empire, where the name of Brazil survived, was a genuine country with soil and rivers and coffee-trees and diamonds; and it has been left for Mr. De Salis to obliterate from the map, not only the empire of Brazil, but pretty much all of the American continent south of the United States. The older geographers represented that South America constituted about one-eighth part of the total land surface of the globe, and that its governments had officially adopted the metric system, excepting the small states of Paraguay and British Guiana. It was stated that about six-sevenths of its area was fertile, and that it was capable of supporting an enormous population.

It is encouraging to find that the word "habitable" can be used in connection with Canada and Australia. They form three-quarters of the British territory; and the delusion has hitherto prevailed that the greater part of one was a frozen desert, and of the other an arid, barren waste.

The statistical argument is of more concern to Great Britain, whose commerce leads the world, than it is to the United States, where foreign trade is at present sub-ordinate to other interests; and whether the figures of British trade are stated correctly or not by Mr. De Salis is of minor importance to us. It may be instructive, however, to compare the foreign commerce of different nations as a partial indication of their relative industrial importance. The means of doing so is afforded by the report entitled "Commerce of the World," by Fred. T. Frelinghuysen, Secretary of State, dated Oct. 1, 1882, and transmitting the annual reports upon the commercial relations of the United States with foreign countries for the years 1880 and 1881. He states the yearly imports and exports of all countries, making for the world a total of about 8¼ billions of dollars of imports and nearly 8 billions of exports. By adding together the imports and exports are obtained the sums shown both graphically and by figures on the accompanying diagram. The Swiss trade is included in that of the surrounding countries, through which it is conducted. The largest item of those collected under the head of "other places" is Japan, with 57 millions.

A glance at the diagram makes apparent the force of Mr. C. L. Hett's remark in the Institution of Civil Engineers' discussion, referring to international trade, He wrote:

"It was sometimes urged that if the United States did not adopt the metric system, why should England? The Americans were agitating for its adoption; and the first country to change would have a great advantage in trading with those other nations who had already adopted it."

American Society of Civil Engineers.

The opening meeting, for the season, of the American Society of Civil Engineers was held on Wednesday evening September 2, and was well attended. The paper of the evening was by W. Howard White on *European Sewage and Garbage Removal*, read by the author. This paper treated of the various methods in use in Europe and elsewhere for the disposal of sewage and general refuse, gave much detail as to prices and results and closed with suggestions for American practice. An animated discussion followed from Messrs. Davis, Fteley, Meyer, Collingwood Emery and Worthen, chiefly directed towards the question of house and sewer ventilation,

The Secretary announced the deaths of Emile Malèzieux, Inspector General *Ponts et Chaussèes* Paris, France, Hon. M. Am. Soc. C. E. and Henry H. Gorringe, Assoc. Am. Soc. C. E., and committees are to be appointed to draw up memoirs of these deceased members.

The Secretary also announced the names of the the following as elected to membership;—

FOR MEMBERS.—David Herbert Andrews, Boston Bridge Works, Boston, Mass; Thomas Sparks Bishop, formerly Assistant Engineer and Engineer in charge of resurveys, Pennsylvania Railroad, now Engineer Russell and Erwin Manufacturing Co., New Britain Conn; Geerge Washington Cooley, formerly in charge of preliminary surveys and construction of Northern Pacific, afterwards in charge of various works from private office; now Chief Engineer of Lyndale Consolidated system of Suburban Railways, and also President of

Engineer's Club of Minnesota; Sidney Willett Hoag, Jr., Assistant Engineer in charge of the Division of Monumenting Department of Public Parks, New York City; Samuel Killebrew, formerly Assistant Engineer on location and construction, Galveston, Harrisburg and San Antonia Railroad, Assistant Engineer and chief of location Mexican International Railroad, now Civil Engineer, Brownsville, Tenn; Milnor Peck Paret, recently Assistant Engineer in charge of Construction Sub. Div., Pennsylvania Schuylkill Valley Railroad, now Assistant Engineer in charge of Surveys and Location on 5th Div. and in charge of construction 3d Sub. Div. P. S. V. R. R., Leesport, Pa; Samuel M. Rowe, formerly Resident Engineer New Mexico Division, now Resident Engineer Las Vegas Division, Atchison, Topeka and Santa Fé Railroad, Las Vegas, N. M; Samuel Spencer, formerly Engineer Savannah and Memphis Railroad, afterward engaged upon New Jersey Southern, Virginia Midland Long Island, and Baltimore and Ohio Railroad: now, First Vice-President Baltimore and Ohio Railroad, Baltimore, Md.

FOR ASSOCIATE.—William Henry Barnes, President National Docks Railway Co., New York; President National Storage Co., Philadelphia; Receiver Allegheny Valley Railroad, Philadelphia, Pa.

FOR JUNIORS.—John Anderson Bensel, in Engineer Corps of the Pennsylvania R. R. Company, office of Engineer of Maintenance of Way, United Railroads of New Jersey Division, New York City; Carlos Ferrer Ferrer, Leveller New Croton Aqueduct, New York City; Maxwell Smith, recently Assistant Engineer, New York City.

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page 140*).

The loss of tractive power of an engine by the resistance of a curve is due to three causes. First, the friction pressure of the outside rail against the wheel flanges in guiding the truck around the curve, which friction increases with the speed and degree of curvature; added to the friction of additional pressure developed by centrifugal force, unless properly elevated. Second, the raising of the entire weight of the train through one half of the elevation. Third, unless properly elevated the resultant $O R$ passing further from one wheel than the other produces diminished adhesion on that side. The extra work of cause No. 2 is saved in Europe by lowering the inside rail below grade one half the elevation required and by raising the outside rail the same extent, thus not affecting the center of gravity of the train. This refinement however is not practised in this country.

Stress was laid above on requiring track on tangents to be spiked to exact gauge, but with curves the conditions of the case are somewhat different. The wheel base of a truck is rigid, therefore it is evident that as curvature increases the play of the wheel gauge is decreased until finally a curve is reached when the outside rail will bind on the extreme outer edges of the flanges, and the inside rail will press against the flanges of the opppsite wheels where they are nearest to each other. But we need not concern ourselves with calculating the widening of the gauge necessary for ordinary car trucks or any short wheel base, but consider that class of rolling stock whose wheel base and arrangement of wheels are most trying. According to the general practice at the present this is the "consolidation" engine with its four drivers on a side connected, although there are in different parts of the country a few engines designed for special purposes, with five wheels connected. Fig. 116 gives a diagram of the "Erie consolidation" which can be taken as typical of the class. The diameter of the wheel is 4 feet, and with the flange 1¼ inches deep it gives the chord of the arc of the flange below the top of the rail to be 1 foot 2⅞ inches.

The lower part of Fig. 116 shows a plan of the flanges of the drivers which are below the top of the rail. The engine is supposed to be standing on an exaggerated curve and the gauge to be such as just to bind, that is, the outside rail touching the front edge of the flange of the forward driver and the rear edge of the last driver. Now if there were a central wheel or if the dotted line indicating the gauge line of the flanges were solid it is evident that the inside rail would be tangent to this line at its middle point. The further the nearest wheel is away from the center the closer the rails can be set, that is the less distortion from correct gauge is required. With the engine in question the nearest wheel to the center is the second driver, but the flange is omitted from this wheel so that the nearest point of obstruction is the flange of the third driver and the front edge of this is the one that binds.

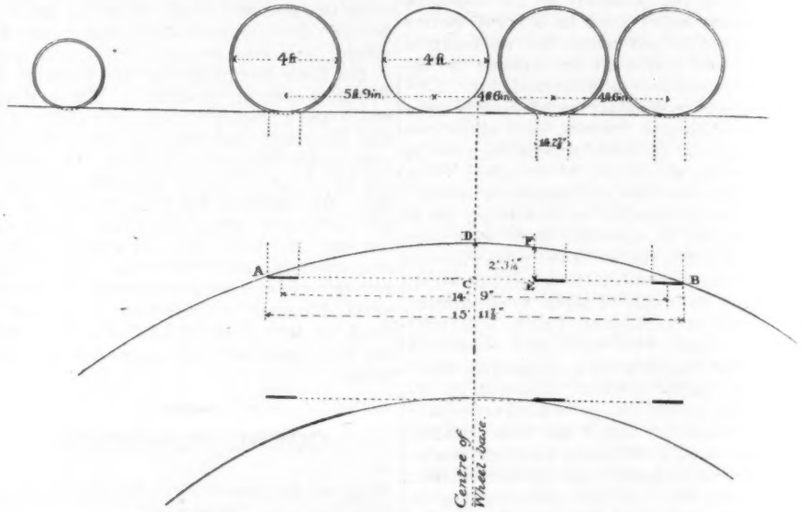


FIG. 116—DIAGRAM OF WHEEL-BASE; "CONSOLIDATION" ENGINE.

It may be incidentally mentioned that a series of experiments were conducted some years ago to determine, with wheels spaced as above, from which the flange could be most advantageously omitted, and driver No. 2 was selected. The reason of the result is here shown. The dotted lines represent the wheel gauge, and by determining the distance $E F$ we find what the gauge of a curve with given radius should be so as to produce the effect as indicated, and by adding three quarters of an inch to this we obtain the track gauge with the same clearance as on a tangent. Properly $E F$ should be measured radially, but the error in measuring it perpendicularly to the chord, $A B$ is inappreciable. The middle ordinate $C D$ (closely approx.) $= \frac{(\text{chord}^2)}{8 \times \text{radius}}$, and neglecting the odd inches, (the omission increases result) the ordinate $E F = \frac{13}{16} C D$, Calculating this to the nearest $\frac{1}{16}$ inch for each degree of curvature from 1 to 10, and tabulating the results gives Table No 8.

An inspection of this table shows that the required increase of gauge is not as great as is currently believed among trackmen who always increase gauge excessively, and furthermore that even with a 10° curve the orginal ¾ inch play is not exhausted. Inasmuch as wheels on curves do not run freely as on tangents, but are always pressed against one rail, it is permissible to adopt such a rule as this based on the results given in the table. Curves under 4° to be spiked true gauge, above that and under one quarter inch wide, above

TABLE NO. 8.

Degree Curve.	Ordinate E. F.
1	1/16
2	1/8
3	3/16
4	1/4
5	5/16
6	3/8
7	7/16
8	1/2
9	9/16
10	5/8

that and under 10°, one half inch and so on, widening a quarter of an inch to each 3°.

(TO BE CONTINUED.)

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LITERATURE.

Transactions and Proceedings; *American Society of Civil Engineers*. June 1885.

CONTENTS:—Address of President Frederic Graff, at the Annual Convention, Deer Park, Md. Description of the Providence, R. I. Water Works to ascertain the force of water ram in pipes. By Edmund B. Weston.

Memoirs of the Tokio Daigaku (University of Tokio) No. 11. A system of Iron Railroad Bridges for Japan. By J. A. L. WADDELL, C. E., B. A. Sc., Ma. E. Professor of Civil Engineering in the University of Tokio, Japan, etc. etc. Tables and Plates, 2 vols., quarto; published by the Tokio Daigaku, Tokio, 2545 (Japanese Era), 1885.

The above is a useful and also a patriotic work by an author already well known in connection with his published works on the designing of bridges. It is written for Japanese engineers and builders, as a record of the professional sojourn of the author among them, and ably points out to them the advantages, in strength and economy of material and time of the American system of bridge construction over those now imported from other countries or designed after English and European practice. If wise the Japanese will heed and profit by his disinterested advice. The text is profusely illustrated, and gives a vast deal of information on this subject of value to his audience. The author points out clearly the system proposed and recommended, and in fact has published a treatise on American bridge construction that would be valuable in any country.

THE Chicago, Burlington & Northern R. R contract, may well be considered a "big contract." It is divided up between three men: W. H. Spafford, D. C. Shepard and E. P. Reynolds. Of the new road, Spafford will build thirty-five miles, Shepard sixty-seven and Reynolds about 250 miles, and it is estimated that 13,000 men will be required to finish it.

ENGINEERING NEWS, Three Months for One Dollar.

Revival of Business.

PHILADELPHIA, Sept. 2—In a review of the business sitnation General Manager Swank of the American Iron and Steel Association, says:

"There is a more hopeful feeling prevailing in business circles in all large manufacturing and business centers. The demand for manufactured products has very preceptibly quickened, and in some lines prices have slightly advanced. The feeling of confidence that did not exist two months ago, and which is now everywhere visible, can be directly traced to the increased business which these two months have brought. If we attempt to discover the influences which have created the increased demand for manufactured products we will all probably agree that a leading influence is the better feeling that exists in railroad circles. It is true that the trunk line difficulties have not yet been fully settled but they are in course of settlement, and that is a great point gained. If the manager of these lines had maintained renumerative rates for freights and passengers during the past two years, general business could not have been so greatly depressed as it has been. * * * To sum up, there is a revival of confidence, an increase in the consumption of nearly all manufactured products, and a strong tendency to higher prices, in many instances higher prices having already been realized. Business is certainly better, and in wool and woollen goods, steel rails, gas and other pipes, and some other specialties it is very much better. The tide has turned."

THE piers of the Quinnipiac Bridge at New Haven, Conn., are crumbling. Bad cement is alleged as the prime reason. The bids for the stone work ranged from $116,843 to $66,000, at which lower figure it was awarded to Mr. John Beattie, of Long Creek. How much of the masonry will have to be repaired is not yet decided upon.

The End of the Stevens Battery.

"If any of the millionaires, who are owners of the new Queen Anne cottages at Babylon, Bay Shore, or some of the other Summer resorts on Long Island," says the New York *Times*," were to be told their handsome woodwork finishings are merely remnants of the old Stevens battery, the statement would probably be received with many doubts. Yet such is the fact. When Mr. Stevens presented the famous vessel to the State of New Jersey, the United States government decided that a man-of-war could not be accepted as the individual property of any state. Mr. Stevens then offered it to the national government, but it was refused as being inadequate to perform the duties required of a war ship. Several suits followed this decision between the estate of Mr. Stevens and the state of New Jersey, which claimed that, although it could not hold the vessel, it was entitled to its value in money. The final decision was in favor of the State, and the Stevens battery as it stood on the ways was sold to Mr. William E. Laimbeer, of New York, for $55,000. He was given six months in which to remove his purchase, but for half of that time he turned it over to the Stevens Institute for the use of its scholars. In consequence, President R. H. Thurston was able to give his pupils three months of the most interesting practical study that has ever been available in this part of the country.

"When all the movable articles had been carted away the two pointed ends of the boat were chopped off and the immense hull, over 400 feet long, was parted by its own weight. The labor of collecting the remnants was then comparatively easy. Immense quantities of giant powder was used, however, to reduce the bulk of the iron to a mass small enough to be carted away. There remains intact to-day but one article that was used on board the Stevens iron-clad steam battery. It is a bronze bell, four feet in circumference. This instrument of household torture rang the working hours at the old shipyard since 1842. A cast mark near the top bears the date of 1841, and it is probably the oldest bronze bell in America to-day. It still performs its duty at the country place of retiring Dock Commissioner Laimbeer, father of the purchaser of the boat at Tenafly, N. J.

"The heirs of Mr. Stevens say that he spent $2,000,000 upon his pet project, in addition to $500,000 granted for the purpose by the government. In his will was a codicil ordering the expenditure of $1,200,000 additional, which was made under the supervision of Gen. George B. McClellan. When put up at auction this mass of iron, that had never been afloat, brought $55,000. It cost Mr. Laimbeer in addition $31,000 to break her up, but by selling it only as raw material he made a very handsome profit,

"The dismantling of the hull occupied the balance of the time allotted the purchaser. On no day during this period were there less than forty men at work, while at times the number ran up to 100. The woodwork was all found to be of the finest Georgia pine in a high state of preservation. That used in the sides of the hull was in layers of a thickness of 5 feet, 6 inches. These layers were dovetailed together and secured by bolts 4 feet long. In and around these joinings creosote was packed in large quantities, and although this wood had been in place for more than twenty years, it was found to be in better condition than when freshly cut. All the skill of the workmen and the strength of the tools could not force the layers of wood apart, and the work was finally done by burning. It was found to be exceedingly dry and susceptible of high polish, and, as has been stated, a large quantity of it has been used in the new cottages built and building on the south shore of Long Island.

"From the hold were taken two engines of 6,000 horse power, each made expressly for use in a twin-screw vessel, and therefore worthless. They were broken up and sold to the Delamater Iron Works, from whence they came. In addition to the two propelling engines there were sixteen driving engines, which were preserved intact and taken to coal mines in Pennsylvania, where they are still used as superior to any new inventions. Over 2,000 tons of iron plate were taken from the battery and sold to the Catasauqua Iron Works, in Pennsylvania, and thirty-three per cent. of it was rerolled in this country. The balance was sent abroad. The bolts used in the construction of the vessel were made in Scotland for that purpose, and possessed unusual tensile qualities.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY JAMES R. CROES, M. SOC. C. E.; INST. C. E.

(CONTINUED FROM PAGE 125)

DCCLXXIV. SOUTHINGTON, CONN.

Southington, Hartford County, Connecticut, in lat. 41° 50′ N. long. 72° 45′ W. is on Quinnipiac River on rolling ground, generally quite level, in a valley between high rocky hills.

Settled about 1690, it was incorporated a town in 1779. Water works were built in 1883-4, by a private company, after plans and under the direction of T. H. McKenzie, C. E., with J. J. R. Croes as consulting engineer, taking the supply from Humiston s Brook, a mountain stream, draining about 2½ square miles of water-shed. The daily average flow of which in 1883 was 4,300.000.

A dam of earth 525 feet long, 16 feet wide on top and 30 feet high with stone masonry and puddle heart and dry stone slope walls, the inner slope being 2 to 1 and the outer 1½ to 1, forms an impounding reservoir, holding 60,000,000 gallons, from which the water is drawn through a 20-inch cast-iron pipe 140 feet long, terminating in a stone masonry gate tower. The distributing reservoir, three-quarters of a mile further down the stream and 225 feet below the storage reservoir, is formed by a stone masonry dam 170 feet long, 20 feet high, 14 feet thick at the base and 5 feet at the level of the overfall. The dam is backed with earth at a slope of 1½ to 1, and has an overfall 40 feet long. There is a brick gate-house with waste and supply gates. The flow line is 213 feet above the public square, and 230 feet, above most of the town. From this reservoir a 10-inch cast-iron pipe, 2½ miles long, conveys the water to the town. Distribution is by 7½ miles of cast-iron pipe of 8 to 4-inches diameter, with 62 fire hydrants, 50 gates and 185 taps. Service pipes are of galvanized and plain iron. The town pays $1,000 for the first year for the use of hydrants. The works have cost $84,500 The capital stock of the company is $60,000 and the bounded indebtedness $25,000, at 5 per cent.

The expenses of maintainance in 1884 were $800, and the receipts at the rate of $4,300. The population in 1880 was 5,411, and is now said to be 7,000. J. B. Savage is President, and T. H. McKenzie, Secretary and Treasurer.

DCCLXXV. SPRINGFIELD, MO.

Springfield, Missouri, in lat. 37° 13′ N., long. 93° 17′ W., is the county seat of Greene Co.

Water-works were built in 1883 by a private company, taking the supply from the head waters of little Sac River. The water is pumped by a pump of 8 inch bore and 24 inch stroke, driven by an overshot water-wheel 10 feet in diameter with 11 foot buckets, and by two Perkins pumps, each of 14 inch steam and 9 inch water cylinders and 22 inch stroke, to a reservoir 322 feet long, 256 feet wide and 14 feet deep, constructed in earth embankment, lined with brick.

This reservoir is 53 feet above the city, and 270 feet above and 3½ miles distant from the pumps, and from it the water is pumped by two Perkins pumps of 16½ inch steam and 12 inch water cylinders and 24 inch stroke, lifting 60 feet to a tower having an elevation above the city of 113 feet.

Distribution is by 17½ miles of cast-iron pipe, with 86 fire-hydrants, 3 meters and 570 taps. Service pipes are of wrought-iron with lead connections. The daily consumption is 500,000 gallons. The city pays $5,300 yearly for fire service. These works also supply the village of North Springfield, Mo., the statistics given include those of that place. The works have cost $162,000. The bonded debt is $100,000 at 6 per cent. The yearly expenses of maintenance are $3,000 and the receipts from water rents $7,000. The population in 1880, was for Springfield 6,522 and for North Springfield 944. P. B. Perkins is President, and Manager, and R. L. Mulhey, Secretary and Treasurer.

DCCLXXVI.—SPRINGFIELD, ME.

Springfield, York County, Maine, in lat. 43° 30′ N., long. 70° 45′ W., is a small village on the Mousam River. Water-works were built in 1876 by a private company, taking the supply from surface water collected in a pond covering 40 acres, and being 167 feet above and 1½ miles distant from the main street of the village.

Distribution is by 3 miles of cast-iron pipe, with 4 fire-hydrants and 150 taps. Wrought-iron is used for services. The population in 1880 was 1,116. No financial statements are given. John A. Dennett is Clerk and Treasurer of the company.

DCCLXXVII, SUNBURY, PA.

Sunbury, Pennsylvania, in lat. 40° 55′ N., long. 76° 45′ W., the county-seat of Northumberland Co., is on the Susquehanna River. It has large business interests in lumber, iron,

coal and lime. Water-works were built in 1883-84 by a private company, taking the supply from surface water.

A dam built across a creek forms an impounding reservoir holding 700,000 gallons, and the water is pumped thence by two Worthington steam pumps, having a combined capacity of 3,600,000 gallons to a reservoir constructed in excavation and embankment, 13 feet deep, the bottom and inner slopes puddled and covered with broken stone one foot deep. This reservoir is 131 feet above and one mile distant from the town.

Distribution is by 11 miles of cast-iron pipe with 40 fire-hydrants and 175 taps. Service pipes are of galvanized iron. The borough pays $1,500 annually for fire service.

The works have cost $100,000. The bonded debt is $77,000 at 6 per cent. The yearly expences of maintenance are $1,500. The population in 1880 was 4,077. John Haas is President, and S. E. Slaymaker, Secretary.

WATER

IT is estimated that the proposed new trunk sewer on Main street, Yonkers, will cost $65,000.

CHARLOTTE, MICH., will hold a meeting September 8, to decide whether or not waterworks shall be built.

ELKTON, Brooking County, Minnesota, is endeavoring to get a water supply, and the Burlington Railroad offers $1,000 toward the enterprise.

THE contract for supplying the town of Warsaw, Ind. with water, has been awarded to the Warsaw Water-Works Company, Warsaw, Ind. Work will begin soon.

WORK on the new sewerage system at Madison, Wis., was begun, August 21st, by Mr. N. Forristall, to whom the contract was awarded at about $13,000.

THE proposed method of disposing of Brockton's (Mass.) sewage by the system of surface irrigation, has received rather a set back by the state board of health.

THE engineers are at work on the surveys for the Bismark, Dak. water works. The plans will follow, and in due time the excavations.

THE Williamsport Water Co. and the Citizen's Water & Gas Co. have been consolidated under one control and management. J. V. Brown is Treasurer, and J. H. McMinn, Superintendent. Total receipts, $41,000; about 3,000 taps.

MR. J. J. FANNING, Hydraulic Engineer, of Manchester, N. H., is in Minneapolis, Minn., by invitation of the board of water commissioners, which desires his advice regarding the prospective extension and improvement of the water supply system of that city.

WELLSBURG, W. Va., has voted by a large majority for water works. B. W. Peterson, City Civil Engineer of Wheeling, has prepared plans, and it is understood that work will commence at once on the construction of the works.

NEGOTIATIONS have been concluded for putting in a system of water works at Bennington, Vt., and work will begin immediately. The proposed site for the reservoir is east of the village, 9,800 feet from the Putnam house, and 309 feet above the sidewalk at that point.

IN building the main drainage works in Boston, 50,000,000 bricks and 180,000 casks of cement were used. The total cost of these works was $5,213,000.

A POPULAR vote on the question of having water-works, at Little Falls, N. Y., was taken August 20, and resulted in a vote of 864 for water and 141 against.

WATER WASTE.—The Detroit, Mich., Board of Water Commissioners are making a brave effort to mitigate the evils arising from the habitual and scandalous waste of water in livery stables. It is said that they will do some heavy sitting down on somebody soon.

MONEY NEEDED FOR RIVERS AND HARBORS.—Washington, Sept. 2,—Gen. Newton chief of engineers United States Army, estimates that an appropration of about $18,000,000 or 20,000,000 will be required to continue the work of river and harbor improvements during the next fiscal year

WORK on the Middleboro Mass., water works has been actively commenced under the direction of the water commissioners. Percy M. Blake of Hyde Park superintends the construction of the entire work. About seventy-five Italians are now laying pipe through Main street, from Grove to Centre, and the standpipe is being erected on Prospect street, near the railroad station. It is expected that the works will be in running order by December 1.

Arthur Doane lately of Boston, has been appointed assistant engineer on the water works.

FIRE ENGINE FOR SALE.—The N. Y. Fire Department will offer for sale on September 10, three self-propelling steam fire engines; three ladder trucks; three extension ladders, and one hand engine.

WORK is progressing rapidly on the new water tower at St. Louis, Mo., now under course of construction at Twelfth and Bissell streets. The foundation has already been completed, and is of solid granite. The first section of the great pipe is now in question. The new tower is three blocks east of the old one. It is thought that it will take three years to finish it.

A NEW "everlasting" wood pavement has been brought out in France. The wood blocks are boiled in a solution of sulphate of copper, sulphate of zinc and chloride of sodium, mixed with heavy mineral oil, linseed oil and tallow. The blocks are afterward compressed to about one-tenth their original volume. In this state they are said to be practically unwearable.

NORWALK, CONN., was on cut off from public water supply since the 23rd, ult. The water was run out for the purpose of cleaning the distributing reservoir, and the pressure from the storage reservoir was not sufficient to drive the water through the siphon connecting the two. A great deal of inconvenience was experienced.

MEDICAL experts who have been examining the Mystic system, Boston's chief water supply, have caused a sensation by reporting that the ponds and streams which contribute to the supply are polluted by the filth from tanneries and factories to an extraordinary extent. The mayor has called upon the new water board for the prompt remedy which the law provides, and the board has promised to apply it.

ROCKFORD, ILL., Aug. 24th.—Rockford people were considerably excited this morning and happily so, when it was discovered that the contractor at the new artesian had struck a splendid flow of 100 gallons a minute of crystal-pure water, at a depth of only 700 feet. Four other wells will be sunk at once.

WORCESTER, MASS., MAIN SEWERS.—The system of sewers is now approaching completion. Considerable difficulty has been encountered owing to the geological formation. The Crystal-Maywood street sewer has had to be constructed partly in open trench at an increased cost; its grade is 37 feet below street grade and the trench is 23 feet wide. The Carson excavator is in use on this section. Forcite is being used as the explosive.

THE WATER SUPPLY AND CHOLERA.—In the weekly report of the National State Board of Health, giving the sanitary condition of the different foreign ports, there is an abstract from the Madrid *Medical News* of August 4th, which states that "the commissioners recently sent into the cholera-infected districts of Spain, report that in all the villages they were able to visit they found the same clinical characteristics of the disease—that in the towns supplied with water from springs and wells, cholera either did not prevail at all, or to a very limited extent, while in the towns supplied with water from streams the disease was very destructive, the water being contaminated by the clothes of cholera-infected patients."

CHICAGO is greatly exercised over the contamination of her water-supply, and not long ago sent out a junketing party to examine causes of pollution whereby to suggest remedies. If the local papers may be trusted, the examinations of beer and sandwiches were extensive, of water slight. Having this excursion in mind, a citizen has written to Commissioner Cregier a description of a simple test for water. It deserves publication for the benefit of alderman everywhere, and therefore we give it:

"To test the purity of water there has been found no better or simpler way than to fill a half-pint flask one-eighth full of the water to be tested, dissolve in the water four tablespoonfuls of the purest sugar (loaf or granulated will do), shake well, then squeeze in the juice of half a lemon, shake again, then fill the remaining seven-eights of the bottle with Old Crow or Mount Zion Bourbon, or sour mash will do very well; shake again, then insert a cork, and slip the compound, bottle and all, in your pocket and go fishing. If you don't want to fish, drink off all but the water and throw the bottle at a mud-turtle."—*Sanitary Engineer.*

THE Norwalk, Conn, water trouble reached a satisfactory termination August 29, after a famine of nearly seven days. It was brought by pumping water into the distributing reservoir, the village steam fire engine, several portable pumps and the engines in two factories combining to force 1,500 gallons of water per minute into it. Harmony being restored there is a disposition on the part of outraged citizens to retract the names showered upon Superintendent Shepard and the water commissioners, for, in the light of facts, it appears that although the shutting off the water by them for a particular purpose at particular time without notice was an error, there was earnest and honest effort afterwards to repair damages. The experience of one week without water will teach Norwalk a lesson which will be of use, especially to its board of water commissioners. Bridgeport *Standard.*

THE Loveland, Col., artesian well has reached a depth of 2,150 feet and no water.

AT a recent town meeting held at South Abington, Mass., to act upon the water question, the following motion was made by C. D. Nash:

That a committee of five persons be chosen to petition in behalf of the inhabitants of South Abington, to the next Legislature, that the Act of the Legislature, entitled "An act to supply the towns of Rockland, Abington and South Abington with water," being chapter 20 of the acts of 1885, be so amended as to set forth more clearly the liability of each town when acting jointly, and particularly to limit the liability of the town of South Abington in the construction of the joint water-works, by fixing some point south of the proposed stand pipe on Beach hill, where the joint liability shall cease; and that said committee be authorized to fix said joint act where in their judgment it would be for the best interest of the town, and to do such things in the premises as may be necessary.

The above was accepted by the town, and a committee of five was chosen, consisting of Hon. W. L. Reed, H. F. Whidden, B. S. Atwood, D. B. Gurney and L. B. Hatch.

THERE is a project on foot to form a water company for the purpose of supplying the three villages of Madison, Chatham and Summit, all in N. Y. The projectors purpose erecting the works and reservoir at or near Madison, and get the supply from Shewongunk and Mount Tabor lakes. The Madison *Eagle* says: "Shewongunk lake is three miles from Mount Tabor lake, and covers 120 acres. This also is a spring lake, surrounded on the north, west and south by mountains, its overflow is at the east, and flows into the Rockaway through Den brook, the stream of water passing near the railroad station at Denville. Shewongunk lake is 684 feet above tide water, and 184 feet higher than Mount Tabor lake. Den brook is less than three-quarters of a mile from one of the springs that flows into Mount Tabor lake, and at small expense and by open channe the water of Den brook will flow by gravity into Mount Tabor lake. By actual measurement the average daily overflow of Shewongunk lake in the months of July, August and September is 682,560 gallons."

WESTBORO, MASS., SEWERAGE,

The report of the committee to recommend a plan for the care of Westboro's sewage alleges that Boston has no tenable ground to order the town not to turn sewage into Cedar swamps.

The report recommends the adoption of the South street plan, and that so much of the system be immediately constructed as shall contain a main sewer of not less than 10-inch pipe for a distance of 3,630 feet. Also that two lateral sewers of 1,250 and 1,220 feet respectively be built, to be not less than 5-inch pipe; that 25 acres, of land be purchased; that an osier bed of not less than two acres be prepared with such distributing pipes at the terminus of main sewer, as may be found expedient together with such dykes and embankments as may be deemed needful for an irrigation field of not less than twenty acres.

That the town having ascertained an estimated cost of a six-inch sewer, together with flush tanks, manholes and all other needed expense, in the construction of said system of sewerage, exclusive of extra cost of main sewer above a six-inch pipe, and exclusive of cost of land, rights of way, and expense of preparing an osier bed and irrigation field, town assess 75 per cent. of such estimated cost upon all and every estate fronting upon any street or way through which such sewer shall be built, based upon the numbre of lineal feet of such estate fronting on such street or way, and otherwise in accordance with such provisions as the town may by vote determine, agreeable to the Public Statutes That is to say, the estimated cost of laying a six-inch pipe, together with flush tanks, man-holes and all other contingencies, over the route proposed for the main sewer, being $6,200, seventy-five per cent. of which would be $4,640. Divide by 7,249 feet frontage of the estates on both sides of the streets, it shows a fraction over 64 cents per foot. But, considering the probable advantage of an easier grade through the rest of the district, our engineers think it will be fair and safe to place the estimate for the whole district 80 cents per lineal foot of frontage upon all the estates through which sewers are or may be laid; and 75 per cent. of this sum will necessitate an assessment of 60 cents per lineal foot of frontage of each estate.

The cost is estimated as follows:

2,430 ft. of 10-inch pipe at $1.25	$3,037 50
1,200 ft. of 8-inch pipe at $1.15	1,380 00
1,220 ft. of 10-inch pipe from Cedar street to disposal bed, at 70 cents	840 00
Gravel filling over bipe between Cedar and New streets	75 00
Flush tanks and man holes	400 05
Engineering and contingencies	925 00
Right of way through private land	110 00
25 acres of land for osier bed, and irrigation field	460 00
Proparation of osier bed, irrigation field and distributing pipes for the same	2,000 00
Total	$10,569 50

In their work the committee has had the assistance of Geo. E. Waring, Jr., of Newport, Hon. Phinehas Ball and S. C. Heald, of Worcester.

THE STATE SEWER.—The survey being made in Worcester and Middlesex counties in the interest of a general system of sewerage for the State is a work that is creating much public interest. The party doing the work consists of Civil Engineer J. F. Williams of Boston, with J. L. Woodfall, H. H. Austin and Henry H. Marden, Jr. George H. DeForrest has been accompanying the party with a boring machine, which he uses for the purpose of testing the soil. The whole work is in charge of Chief Engineer Eliot C. Clarke, and in different portions of the commonwealth he will have a dozen other engineers with assistants. A report of the whole work is to be rendered to the Legislature next winter. The work is now being pushed westward and toward Worcester. The towns lying contiguous to the Sudbury river system of Boston's water supply are particularly interested in this scheme for a general system of state drainage, for it may help them out of a very serious difficulty. Marlboro already has an engineer at work perfecting plans for a system of town sewerage; Clinton has just voted to petition the legislature for authority to build sewers: Westboro will hold a special town meeting this week for the purpose of taking action relative to the introduction of a sewerage system, a plan already having been made whereby an expense of over $10,000 will be entailed, and Framingham and other towns are exercised in the matter.—*Boston Herald.*

BOSTON WATER SUPPLY.

The report of the commission appointed to inquire into location and extension of the high service water supply system, contains the following estimates:

Estimate of Cost of Proposed Extension.

Pumping station at Chestnut-hill reservoir, including connections etc	$142,000
Force main to Fisher-hill reservoir, including gates, special castings and 16-inch connection with Brighton distribution	75,000
Fisher-hill reservoir, including gate-house, chambers, etc	141,000
Supply main 30-inch diameter from reservoir to Prince and Perkins streets, and 24-inch diameter thence to Parker hill reservoir	127,000
	$485,000
Add 10 per cent. for engineering, etc	48,500
	$533,500
To this add cost of reservoir site on Fisher-hill, and of pumps, boilers and appurtenances at Chestnut-hill reservoir, as per contract	$197,000
Total	$730,500

The commission also offers the following estimate of cost of the Peters-hill extension of the high service:

Supply main, 24 inches diameter, from Prince and Perkins streets to Peters-hill reservoir, including necessary gates, special castings, rock excavation, etc	117,360
Peters-hill reservoir and appurtenances	140,000
16-inch main from reservoir to South street, including rock work etc	7,600
	$264,900
Engineering, etc., 10 per cent	26,490
Total	$291,390

Estimate of Cost of West Roxbury High Service.

8,800 feet 12-inch pipe laid	$19,800
350 feet 8-inch pipe, laid	525
Rock excavation along line of pipe	2,000
Pumphouse	4,000
Lot of land for same	500
Pumps	3,500
Tank, 25 feet diameter by 32 feet high	3,000
Observatory over and around tank	5,000
Automatic indicator	1,000
	$39,325
Engineering, etc., 10 per cent.	3,932
Total estimated cost	$43,257

The annual cost of operation would probably not exceed $3,000.

The following is submitted by the consulting engineers:

[COPY.]

BOSTON, August 28, 1885.

Hon. Hugh O'Brien, Mayor of Boston:

SIR—In compliance with your instructions to consult with the special commission appointed to report upon the high-service supply, we have visited with its members the district to be supplied, and after giving careful consideration to the subject and examining the report and maps of the commission, we beg to report as follows:

The district to be ultimately covered by the high-service system being much the larger portion of the territory now supplied from the Cochituate and Sudbury works, it is important, as suggested in your communication to the City Council of June 15th, that the system which may be now adopted, shall be such that, while the portion to be built for the needs of the present and of the near future may be built at reasonable cost the same system by successive enlargements may be made to meet the wants of an increasing population, however large that population may become in the future.

We are of opinion that a supply from Charles river, whether obtained directly or through the Brookline works, cannot be recommended, and we agree with the conclusions of the commissioners' report:

First—That the Chestnut hill reservoir is the most advisable source of supply.

Second—That the water should be pumped therefrom into a reservoir located in the neighborhood of the pumps, and that the most favorable location for such a reservoir is Fisher hill, as it is the most available center of distribution for the Brighton district, and affords facilities for building a reservoir of the desired capacity and elevation.

Third—That economy and efficiency require the division of the territory to be supplied into sub districts, with a reservoir for each as a center of distribution. The Parker-hill reservoir is a good center for Beacon hill, South Boston, Roxbury and the northern portions of West Roxbury and Dorchester; Peters hill is favorably located for a reservoir to command the southern parts of West Roxbury and Dorchester, and as before stated, Fisher hill is the most favorable site for a reservoir to command the Brighton district.

Fourth—That it is advisable to provide a separate system of high service for the small areas in West Roxbury above elevation 170.

Although we have not been able to review with care the estimates of the cost presented by the commissioners, we are of the opinion from our general knowledge of the conditions that the works recommended can be built for the sum estimated.

Respectfully submitted,

JOSEPH P. DAVIS,
A. FTELEY,
E. C. CLARKE,
Consulting Engineers.

WATER RATES.

The following carefully prepared table will show the comparative rates of eleven principal cities on the various items for which charges are specified:

Comparative Table of Rates.

Cities.	Yard Sprkr.	Baths.	Pv'te St'bls.	Livery Stables.	St'm Eng.	Sal'n.	Water Closets.	Dwellings.	Meters.
Albany	$3.00	$3.00	$3.00	$2.00—1.00	$3.00	.....	$2.00	$8—10.00—13.00	40—1c
Buffalo	3.00	5.00—3.00	4.00	2.50—1.50	6.00	$13.50	5.00—2.50	12—15.00—18.00	3—2
Chicago	3.00	2.00—1.00	3.00	3.00—1.00	5.00	16.00	2.00—1.00	9—11.00—15.00	1
Cincinnati	3.00	6.00—3.00	3.00	3.00—3.00	.....	12.50	6.00—3.00	8—10.00—13.00	1¼
Kansas City	10.00	5.00—4.00	2.00	2.00—2.00	4.00	15.00	4.00	8—11.00—13.50	3¼—1¼
Milwaukee	5.00	3.00—3.00	2.00	2.00—2.00	4.50	10.00	3.00—2.00	8—10.00—13.00	2
Portland, Me.	5.00	5.00—3.00	8.00	8.00—8.00	.....	.....	6.00—3.00	10—12.00—15.00	5—3
Rochester, N. Y.	4.00	4.00—2.00	3.00	1.50—1.50	4.30	10.00	3.00—2.00	5— 8.00—10.00	3—1
St. Louis	5.00	5.00—3.00	4.00	2.00—2.00	6.60	20.00	5.00—5.00	7— 9.00—12.00	2—1¼
Minneapolis	3.00	2.50	2.00	2.00—2.00	4.00	15.00	3.00	3— 3.75— 4.75	2—1
St. Paul	3.00	4.00—3.00	*6.00	2.50—2.00	5.00	10.00	5.00—4.00	10—11.00—14.00	4—2
Average	$4.27	$4.95—2.77	$3.64	$2.77—2.54	$3.77	$13.10	$4.05—2.92	$8—9.98—12.34	2.9—1—1.5—1

*Charge for entire stable not per head.

In this table, under the head of baths and water-closets, the figures of the second column represent the charge for each additional bath or closet after the first. Under livery stables, the second figure is the charge for every head of stock after the first thirty. Under dwellings, the first figure is the charge for a six or seven-room house; the second, for a seven to ten, and the third for large houses. Under meters, the first figure is the charge per 1,000 cubic feet, and the second the lowest charge where large quantities are used. It will be noticed that Minneapolis rates are considerably lower than those of any other city on the list. For dwelling houses St. Paul charges considerably more than Minneapolis, Rochester, or St. Louis, a trifle more than Albany, Cincinnati or Milwaukee; a trifle less than Buffalo or Portland, Me., and about the same as Chicago and Kansas City. It will be seen by the table that St. Paul rates are higher than the average of these cities on steam engines, water closets, dwellings and meters, and below the average on yard sprinklers, baths, livery stables and saloons. Taking the places where most water is used, St. Paul rates are above the average. St. Paul charges $6 for a private stable without taking into account the number of horses. Other cities charge per horse. Kansas City, Milwaukee and St. Louis charge $5 extra for the use of a hose at a private stable and $50 extra at a livery stable. Rochester charges $4 and $10 respectively for such hose, and Minneapolis $20 for hose at a livery stable. St. Paul makes no such charge.—*Pioneer Press.*

NEWS OF THE WEEK.

Railroads, Bridges and Canals.

Memphis, Oxford & Columbia R. R.—The report of the survey was received on the 26th ult. and construction work at an early day is probable. The head-quarters are Memphis.

Atlantic & Pacific R. R.—President H. C. Nutt says that the branch from Pierce City to Red Fork would be extended 100 miles west of the latter place this year.

Southern R. R. Building.—A movement is on foot to connect Elberton, Ga., with the Savannah railroad by building a short branch, which will open up some of the most valuable lands in the State.

Stone Ballast.—The Wabash Company is making arrangements to replace the gravel ballast on the main line with crushed stone as rapidly as it may be required. Two or three stone-crushers are now engaged in preparing this material.

The Wisconsin Central Railroad company has purchased 14,000 tons of steel, rails for its new Chicago extension, from the North Chicago Rolling Mill company. The price paid for the rails which it is said will come from the company's works at Joliet, was $26 a ton.

Sale of the Chicago and Great Southern R. R.—The sale of this road, which runs from Fair Oaks to Brazil, Ind., is advertised to take place at the Indianapolis court-house on October 14th.

The Janney Coupler and Buffer.—The Jury Commission of the International Inventions Exhibition, of London, have awarded a silver medal, the highest premium issued, to the "Janney Coupler and Buffer.

Providence, Warren, & Bristol R. R.—This road has filed notice of location of a branch in East Providence, and a meeting will be held Sep. 12th, to elect persons to estimate damages to property.

St. John's River Bridge.—It will require 500,000 feet of timber to construct the bridge across the St. John's river at Lake Monroe, for the Jacksonville, Tampa and Key West Railroad.

Fremont, Elkhorn & Mo. Valley R. R.—The final survey of the line north from the Cheyenne river is in progress. Heavy grades are allowed. Contract for 60 miles of grading north of Chadron, has been let, and probably, in all, 101 miles will be completed before winter.

Georgia R. Rd's.—E. A. Pratois, C. F. Smith, and E. C. Sammis say they will organize in Jacksonville, on Nov. 10th, the East Coast Railway Company, for the purpose of constructing, maintaining and operating a railroad between Jacksonville and Titusville, together with certain branches and ferries.

Lively—On the great incline on the Canadian Pacific, between Donald and Stephen, several switches are constructed, running sharply up hill, at which men are stationed to run in and stop portions of trains breaking away on the heavy grade. The plan has worked well, and it is claimed that several trains have been saved from dashing to pieces by the device adopted.

Steel Rails for Alabama.—The Western railroad of Alabama has received the first shipment of 3,000 tons of steel rails to be laid between Montgomery and West Point. When these rails shall have been laid the whole route will be steel.

A large invoice of steel rails was recently received for the Alabama division of the the East Tennessee, Virginia and Georgia railroad, which will be laid as soon as they are distributed along the line of the road.

Paying R. R. Employees.—A new law is now in force in Indiana, requiring railway and other corporations, doing business in that State, to pay their employes "engaged in manual or mechanical labor" at least once a month, unless otherwise agreed in writing. The penalty of neglect to do so is a fine of $1 per day and reasonable attorneys' fees. So far as railway companies are concerned they are in the habit of paying wages every month if they have the funds. If the Legislature of Indiana had contrived some method by which the roads could always get money to pay their bills it would really have accomplished something.

The Lookout Mountain Railway.—CHATTANOOGA, Tenn., August 24.—To-day a force of hands began work on the long talked of railroad up Lookout Mountain A year ago it was supposed Colonel Cole, of Nashville, would build the road, but his project fell through and it left the enterprise in the hands of a company headed by Major King, United States engineer in charge of the Tennessee and Cumberland river improvements. For years he has been perfecting a model and completed it several months ago. The company has proceeded quietly at work. The entire right of way is secured and every detail is arranged. To-day the force begun the work of grading and the work will go ahead until finished. It will be an incline road with the engine in the center. The cars will be worked by cables.

Pacific R. R. Mileage—The mileage of Pacific railroads is 12,903, or more than one-tenth of the total for the whole country. These roads had net earnings of $30,000,000 last year.

The Lafayette, Newtown and Wabash River Railway company was incorporated Aug. 27th. The company's capital stock is $1,000,000, and the line, when completed, will connect Lafayette and Terre Haute, and will be in length eighty-two miles. President Henninger says that an English company has bought the bonds of the road, has furnished the money, and that the contracts have been let for the construction of the line without delay.

The Fargo, Moorhead and Northwestern filed articles of incorporation with the secretary of State of Minnesota, Aug. 15th, stating that the object of the corporation was to operate a railway with all the necessary appurtenances from a point on the Red Lake River, near Moorhead, by the most feasible route to Ada, Norman county, and thence in a northerly direction to a point on the Red Lake river in Polk county. The place of business is to be at Ada, and the commencement of the corporation Sept 15th, 1885. The capital stock is $1,000,000, divided into 10,000 shares. The incorporators are R. A. Wilkinson, Crookston; John M. Martin, D. H. Fisk, Fred Puhler, A. H. Baker, Ada, and Otto Kaukle and Albert Gilmour, Pertile. The first board of directors are the incorporators. The officers are R. A. Wilkinson, president; John M. Martin, vice president; Fred Puhler secretary, and D. H. Fisk, treasurer.

The Chicago, Burlington & Northern Railway filed articles of association at the State House in Madis on Wis., on the 28th ult., the object being to construct a line in Wisconsin from a point in Grant County, opposite Dunleith, Ill., to Prescott, Pierce County. It will be 225 miles in length and extend through Grant, Crawford, Vernon, La Crosse, Trempeleau, Buffalo, Pepin, and Pierce Counties. The capital stock is $4,500,000, and the incorporators are W. H. Holcomb, R. C. Brundage, W. B. Lawson, J. W. Traer, John Brindley, G. W. Traer, and J. J. Fruit, all of La Crosse. This is practically the Alma & Northern Company, incorporated two years ago, reorganized under a new name. The Alma & Northern recently let contracts for part of its line, and work is already under way. The Chicago, Burlington & Northern bought out its right of way, franchise, and plant, and will make it the chief link in the Chicago, Burlington & Quincy's line to St. Paul.

Mount Kearsarge Railroad.—Mount Kearsarge, one of the lesser of the White Mountain range in the State of New Hampshire, U. S., has for many years been a noted resort for lovers of mountains on account of the diversified beauty of the scenery viewed from the summit. Although only 3251 feet in altitude, many travellers prefer it to other of the White Mountains reaching to twice the height; in its outline from some positions it reminds one of Mount Vesuvius. Hitherto it has been scaled by a bridle-path somewhat too steep and slippery on the ledges for horses to be used with perfect safety, reaching nearly to the summit. The construction of a mountain railroad has been commenced. Instead of the rack and pinion system adopted on Mount Washington Railway and elsewhere, or an inclined railway where cars are drawn by ropes pulled by stationary engines, an ordinary traction railway of 2 feet gauge is to be used and by laying it out in the form of a volute the maximum grade is 265 feet to the mile, and the length of the road will be 11½ miles, or about five times that of the bridle-path. By continually encircling the mountain, a variety of landscape views will be obtained from the trains. Some of the curves are necessarily sharp, the highest curvature being 30 degrees.

New Canadian Bridge.—For some little time back the C. P. R engineers have been going over the measurements and soundings formerly made between Lachine and Caughnawaga on the site of the proposed bridge. Work is shortly to be commenced on this structure, and the soundings are to be made over again to prevent the possibility of any mistake necessitating a change of plan after the contract has been given. The line by which the C. P. R. will reach this bridge has been already built as far as Cote St. Luke. From there to the St. Lawrence the road will cross on a thirty feet embankment, crossing the G. T. R. main line, Lachine branch, and Lachine road by bridges. The line will be carried over the canal by a swing bridge 40 feet above the Summer level of the canal. Being so high this bridge will be opened very seldom. The St. Lawrence bridge site is about two miles above the rapids and about a hundred yards from the monastry of the Oblat Fathers. The bridge proper will be of iron, and about 3,300 feet long, crossing the river by twelve spans. Eight of these will be 208 feet, two of 260 feet, and two with a headway of 60 feet above the Summer level, will have a clear span of 403 feet. The river bed is most favorable for bridge building at this point, only one pier having a depth of 29 feet, and the other eleven not averaging more than 12 feet. It is estimated that the whole cost of the bridge and approaches will be in the neighborhood of two and a half million dollars. From the Caughnawagn side of the bridge a line will have to be built to Chambly or St. Johns.

The Kansas City Line.—Engineer W. M. Miller and his assistants were at Marshall, Mo., last week, making the survey for the projected Air Line Road from St. Louis to Kansas City, via that city. So far the survey has proven very satisfactory.

Nashville Bridge.—Flannery & Aiken have qualified duly in bond and are beginning work on the Nashville, Edgefield bridge approach. Messrs. Marshall, Morris & Co., declining the work as it is said that the commissioners required the accounts for bond to be removed from Louisville to Nashville banks.

Northwestern R. R. Extension.—Engineer Jno. E. Blunt, of Winona, is making arrangement to extend the survey of the Northwestern road through Yankton, county, Dak., immediately. The company intends to go on in the spring from its new river point, and will do as much work as possible this fall. The coming of the Northwestern will give Yankton two eastern inlets and two western outlets.

Jersey City Elevated R. R.—Jersey City has a new elevated railroad that will be also a cable road. The machinery is now being tested. The cars will be put on and the employees set about learning how to run the grips in a few days, and the road be opened to the public about September 25th.

A New Railway at Chautauqua—The Chautauqua Lake Railway company has organized to build a railway from Jamestown along Chautauqua lake to Mayville and, possibly, around the lake a distance of forty miles A. A. Pope, of Boston, is president, R. N. Marvin of Jamestown, vice president, and Eugene F. Fey of Boston, secretary and treasurer.

N. H. Railroad.—The Railroad, Committee of the Legislature of New Hampshire has reported a resolution requesting the Railroad Commissioners, to inquire into the expediency and expense of requiring all railroads of the State to rebuild all their bridges. The same committee reported a bill prohibiting the stopping of trains on highways more than two minutes.

The Denver, Western & Pacific will be built this fall to Boulder, by the Union Pacific R. R. which will greatly shorten the distance between that point and Denver, and will serve to open up all the country lying northwest of Denver. Besides this the U. P. will build a branch from Golden up Ralston Creek to some of their property.

The Denver, Memphis and Atlantic Railroad Company commenced work at Conway Springs, Sumner County, Kan., on the 25th ult., with a large force of teams and men. The right of way has been secured for sixty miles out of Conway Springs. This road will run east through Sumner, Cowley, Chautauqua, Montgomery, Labette and Cherokee Counties, Kan. The headquarters of the road is now located at Belle Plain.

Saugatuck Valley R. R.—Surveyors are at work finishing the survey of the Saugatuck Valley Railroad to Hawleyville, the terminus of the route. The survey was left unfinished, last fall, at a point six miles from that place. Those connected with the project have announced their intention of beginning construction this fall and if so, grading must soon begin.—Bridgeport, Conn., *Standard*.

Uniting Underground Railways.—The various companies that have charters to build underground railroads in this city are trying to consolidate in order to build a single road. A circular has been issued by the Western Union Telegraph Company, proposing to form a syndicate to control the charters of the New York Underground Railway Company and the Broadway Underground Railroad Company.

A Tall Road in Northwest Missouri.—A corporation to be composed of the business men of Chillicothe, Mo., is being organized, having for its object the construction of a high-graded road across grand River bottom south, a distance of 9 miles, and the erection of iron bridges over Grand River and Shoal Creek. The capital stock is $30,000, with shares at $100 each. The stock is being taken rapidly.

East Tenn. Va. & Georgia R. R.—Capt. E. N. Gloster started 25th ult., with a full party on survey from Memphis, Tenn. to Birmingham, Ala., 180 miles in interest of E. F. Vand, Ga. R. R.

At a formal meeting of Directors of East Tenn. and Midland Ry. at Galveston Tenn. a permanent organization was effected, with W. S. Mundy, of Gallatin as President. Fite, of Carthage, Vice President, and D. B. Anderson, Secretary. They announced their intention of pushing the road.

The Congo R. R.—KING LEOPOLD of Belgium has written a letter to the President of the Royal Geographical Society, in which he says with regard to the proposed Congo railroad: "In order that the Free State of Congo may render to civilization and commerce the services we expect, it is necessary that we build the railroad between Vivi and Stanley Pool, and that we place the most capable agents at the head of the African State. We are now actively engaged with the railroad, the surveys for which are in progress. We do not wish to launch our project until the surveys are completed and we are in accord with mercantile houses.

Chicago & Western R. R.—It will cost the Chicago & Western Railroad Company about $2,000,000 to get into Chicago, for right of way alone.

R. R. Extension.—There is little doubt at present that the Carson and Colorado Narrow gauge will be extended to Waterman, the junction of the California Southern with the Atlantic and Pacific.

Car Works Reopen.—The Lafayette car works will resume operations after an idleness of several months. About 300 men will be employed, and the works have orders ahead for several months.

La Crosse & Black River.—Articles have been filed with the secretary of state of the La Crosse & Black River Railroad company. This is a company organized by J. B. Canterbury, who built the Onalaska Short Line and sold it to the Milwaukee & St. Paul company.

The Largest Boiler ever constructed for any locomotive at the West Albany shops of the New York Central road is now under way. It has 52-inch shell, 2 inches larger than any other, made of 7-16 inch iron. There will be 228 tubes, 28 more than in any other boiler, and it will carry 160 pounds of steam. The boiler is 16 inches higher than the usual run, and, all told, weighs over 8 tons.

Railroads in Missouri.—The total assessed valuation of the 4,553 miles of railway in Missouri for the present year is $40,955,319. Over one-third of this amount ($14,032,305) is assessed against the Missouri-Pacific and the St. Louis Iron Mountain and Southern. The valuation of the Hannibal and St. Joseph and branches is $4,371,758, and of the St. Louis and San-Francisco system, $3,620,853. The assessment shows an increase in mileage of 66 miles and in valuation of $2,575,002.

Baltimore & Philadelphia R. R.—All the grading and tracklaying on the Baltimore and Philadelphia Railroad, it is now stated, will be completed up to the Philadelphia line by Sep. 1st. The connection of the Reading Railroad, it is now stated by the engineers, will be completed in another eight months, and, it is expected by the officials, the trains of the Baltimore and Ohio Railroad Company will be running to New York by that time. The Baltimore and Philadelphia line was built under a loan of the Baltimore and Ohio Railroad Company for $12,000,000, which was placed in England at 4½ per cent.

Duluth and Northern.—Articles of incorporation of the Duluth & Northern Railway Company, with the principal office at Duluth, were filed Aug. 20th with the secretary of state. The capital stock is $3,000,000 and limit of liability the same. The company is to construct and maintain lines of railway leading from Duluth to the northern boundary of the State, with branches and extensions. The incorporators are Charles F. Hatch, Minneapolis; L. Mendenhall, A. Miller, D. C. Duncan, R. S. Munger, F. R. Webber, F. F. Huntress, Duluth; T. B. Casey, George H. Christian, Minneapolis. All of these, except Messrs. Miller and Webber, constitute the first board of directors, to serve until the first Wednesday in May, 1886.

Railroads in Colombia.—A correspondent of the New York *Herald* says that the United States of Colombia, with a surplus revenue of only $1,000,000, have undertaken the following subsidized projects:

A railroad from Cauca to the Pacific, of which 30 miles have been constructed.

A railroad frem Cundinamarca to the Magdelena river, 15 miles built.

A railroad from the Magdalena to the capital of the State of Antioqula, 48 miles built.

A railroad between the upper and lower portions of the Magdalena, where navigation is interrupted by the rapids, 16 miles built.

A railroad from Santander to the Magdalena, 6 miles built.

Railroads from the seacoast to Barranquilla and Clenaga, in the State of Boliver and Magdalena, 32 miles built.

Broadway Underground Railway.

It is said upon what is considered good authority, that the Broadway underground railway scheme regarding which so much has lately been said by the press of this city, is assuming such business like shape as to insure the building of the road. The enterprise is one of enormous magnitude and the six and one half miles now under contract from the Battery to Harlem, and its branches will cost according to surveys and estimates, made and carefully supervised by Gen. George B. McClellan, from $1,200,000 to $1,400,000 per mile. A contract has been let for building the road. Many leading capitalists and business men of New York are interested in the enterprise. The entire structure will be continually lighted by electricity, and the trains run by electric motors. The road when built will solve the underground wire problem in New York. Arrangements have already been made with the American Electric Manufacturing company by which the American company will control the lighting of the great structure, supply the electric motors, as well as for the control of the right for placing telegraph, electric light, telephone, fire alarm, and other wires in the structure.

Checking Train Walkers.—The German *Organ for Railroad Progress* gives the following method of checking up the track watchmen as practiced on the Russian road from Charkov to Nikolajev. The track is patrolled before each train by a watchman on each section, who carries forward a number found by him at the beginning of his section and left on a hook provided for it at the end, even numbers being carried in one direction and odd ones in the other. The numbers, which are painted on metal plates, are hung in view of the trains, so that officials passing can readily see them, and by means of a small table of the positions of the numbers on any day or hour can see whether the watchmen are doing their work. A hook without a number indicates the negligence of a watchman, who can be readily identified, since every watchman is required to give notice when he does not find a number at the beginning of his section, and must do so to avoid having the carelessness ascribed to him.

American and Foreign Railways.—The London *Economist* recently had an article on railway traffic returns in Great Britain and abroad, with a table giving earnings and mileage, and the increase or decrease per cent., as compared with 1884. The table shows that twenty British lines, for the half year to June 30, decreased their earnings £636,000 The increase in mileage was 1.20 per cent., and the decrease in earnings 2.19 per cent.

The total French lines from Jan. 1 to June 24 increased their mileage 1,036, or 6.66 per cent., and decreased their earnings £764,000, or 3.87 per cent.

The total German lines (excluding Bavarian) from Jan. 1 to May 31 increased their mileage 913, or 2.96 per cent., and increased their earnings £5,000, or .03 per cent.

The Austro-Hungarian and South Austrian lines from Jan. 1 to June 24 increased their mileage 107. or 2.39 per cent., and increased their earnings £37,000, or 1.09 per cent.

The Spanish railroads from Jan. 1 to June 24 increased their mileage 524 or 8.10 per cent., and increased their earnings £78,000 or 3.00 per cent.

The South Italian lines from Jan. 1 to June 24 increased their mileage 125 or 6.98 per cent., and increased their earnings £49,000, or 7.01 per cent.

Fifty-six American lines from Jan. 1 to May 31 increased their mileage 780 miles, or 1.56 per cent., and decreased their earnings £121,000, or 0.76 per cent.

Canadian Railroad Statistics.—The railway equipment of Canada is something of which its people may well be proud. Take the last eight years. The number of miles built during 1877-8-9 (three years) was 1,327; equal to 442 miles a year. The number of miles built during 1880-1-2-3-4 (five years) was 3,091; equal to 680 miles a year. Canada increased its mileage in those eight years from 5,157 miles in 1876, to 9,665 miles in 1884. When the present Government came into power Ontario had 2,564 miles of local roads in operation. In June, 1884, she had 3,304 miles. In 1879 Quebec had 758 miles of local roads. In June, 1884, she had 935 miles. In 1879 there were parts of the present C. P. R. in operation, Canada Central, etc., covering 207 miles. In June, 1884, there were 2,491 miles, not including leased lines such as the Toronto, Grey and Bruce, the Credit Valley, and the Ontario and Quebec railways. Taking the Dominion all through in 1875 there was about one mile of railway to every 900 people. In June, 1884, there was one mile to every 520 people.

In 1875 there were 2,000 miles of steel rails. In 1884 there were 8,348 miles. In 1875 the railways of Canada owned 966 engines, and hired 14, or a total of 980 required to do their work. In 1884 they owned 1,455 engines and hired 26, a total of 1,481 required. In nine years there was an increase of 500 engines.

In 1875 the railways of Canada owned 1,000 passenger and baggage cars.

In 1884 they had 1,558 such cars.

In 1875 they had 19,247 box, cattle, and platform cars.

In 1884 they had 35,466 such cars.

In 1875 they had 1,050 cars for carrying coal and iron.

In 1884 they had 1,941 such cars.

In 1875 the train mileage run was 17,680,178.

In 1884 the train mileage was 29,758,676.

In 1875 the passengers carried numbered 5,190,416.

In 1884 they numbered 9,982,358.

In 1875 the freight carried was 5,670,836 tons.

In 1884 it was 13,712,269 tons.

In 1875 the sum expended in maintenance of lines and buildings, working and repairs of engines and cars and general operating expenses was $15,450,000. In 1884 the sum distributed among the artisans, mechanics and laboring class for the same purposes was $25,600,000. Up to June, 1875, the Dominion Government had expended on account of loans or grants, and outlays for and surveys upon portions of the C. P. R., and not including loans to Grand Trunk ($15,143,000) the sum of $42,876,000. Up to June, 1884, the expenditure was $134,000,000 including the loan of $29,880,000 made to the C.P.R.

As a result of this development of railway facilities the average cost of freight per ton was reduced from $2.11 to $1.51, a reduction of 60 cents per ton on the general average. As a further result the average cost of passenger rates per passenger was reduced from $1.23 in 1875 to $1.12 in 1884. Had the ten million passengers who used the railways in 1884 been obliged to pay the rates of 1875, the public would have had to pay $1,100,000 more than they did. Had the rate of freight been the same in 1884 as in 1875 the public would have been obliged to pay $8,227,362 more than they paid in 1884.

Here, then, on passenger and freight rates a saving has been effected of nearly $9,400,000.

The Government have added to the debt the sum of $134,000,000 for railways, including the loan to the C. P. R. of thirty millions. As there is interest on that thirty millions, it costs the country nothing. It leaves $404,000,000 of debt, on which interest is paid at 5 per cent., equal to $5,200,000. The people therefore pay $5,200,000, and save $9,400,000 a year.—Toronto *Mail*.

Contracting.

New Bridge.—Two Pennsylvania railroad surveyors have surveyed the old bridge at the Hilford, Del. depot with the object of building a new one and doing away with the curve just north of the depot.

The Brooklyn Elevated Railway have made a contract with William C. Baker, of the Baker Car Heater Company, 72 Broadway, New York, for the heating of the railway's cars. The apparatus which will be used is a recent improvement upon the heater now in use on the Pullman palace cars.

The B. & O. Bridege over the Schuylkill.—Gen. Wm Sooy Smith & Son, launched the caisson for the center pier of the B. & O. bridge over the Schuylkill on Aug. 31st. It is octagonal, 49 feet in diameter, and weighed about 300 tons. In the absence of Col. Patton, who is ill. W. D. Jenkins is the engineer in charge.

Newport and Covington Bridge.—L. L. Buck, C. E. of New York, under date of Aug. 27, submitted a report upon the present condition of the Newport and Covington Bridge, including a minute description of the structure as it stands, with its detail of cables, towers, etc. In regard to strength, he says that with all the wires equally strained the factor of safety would be only 143, and a load of 1777 pounds leniel foot would strain them above their elastic limit Ten per cent. of the cable wires are eaten away by rust; there are no external indications of weakness in the anchorage, and the floor beams are not nearly strong enough. In conclusion, Mr. Buck condemns the bridge. The directors of the bridge are now conducting bids for a new bridge. the Keystone Co. offering to erect a brass bridge for $70,000 with two wagon-ways of 20 feet each and two foot-ways of 5 feet each.

St. Paul Contracts.—At the joint meeting of the St. Paul council and board of county commissioners, Aug. 25, the resolution of the court house commissioner awarding the contract for building the superstructure of the new court house and city hall to Mathias Breen was read, approved and signed by the members of the joint assembly. The contract provides that the work shall be completed by Sept. 15, 1884. the contract price therefor being $264,300. The contract was presented, accompanied by a bond of idemnity in the sum of $50,000, with Patrick Keighar and Enoch F. Berrisford as sureties. Mayor Rice announced that during the present month a contract would be presented for the iron at this time, on account of the low prices. There being no further business, the joint assemblage adjourned.

Sewer and Paving Bids.—The following bids for paving and for the construction of sewers were opened in the engineer's office, Buffalo, August 31. To pave Hamburgh street, the lowest bid was that of A. M. Holloway, $16,490, the highest James Howells, $18,589.44; paving Spruce street, lowest A. M. Holloway, $2,385, highest L. Hettrich, $3,529; paving Jefferson street John Muller, $6,835, James Howells highest, $8,258.60; paving Mortimer street, lowest John Muller, $6,000, highest James Howells, $6,788; paving Broadway, lowest John Muller, $10,900, highest C. E. Williams, $12,900; for sewer in Delevan avenue, lowest George & Thomas Dark, Jr., $13,450, highest Geooge Martin, $17,796; sewer in Richmond avenue. D. W. McConnell lowest, $1,994, highest George & Thomas Dark, $2,100.

The Fastest Tunnel on Record.—The fastest driving yet done on the New York Aqueduct was accomplished during month ending August 15, at Shaft 20,—Section B. under supervision of Messrs. Collins and Farwell and Foreman McLoughlin. In July the contractors, Messrs. O'Brien & Clark, issued the following notice naming a prize which was won by men of above named shaft:

YONKERS, N. Y., July 6, 1885.

We have concluded to offer the foremen in charge of the tunnel on our work premiums to the amount of $300 to the gangs making the fastest record for the month commencing July 15, 1885, and ending August 15, 1885, as follows:—viz., $200 first premium. $100 second premium. The manner of deciding the greatest progress will be as follows:—As near as possible uniform run be made of both bench and heading. Should the bench exceed the heading, then four feet of bench will count three feet of heading. In case the large timber sections are required, then the number of yards will be compared against the small sections, as above indicated. The foreman winning the premiums will be at liberty to distribute them as they may see fit among their workmen. The record will be kept by J. Breuchard and W. W. Hegeman.

O'BRIEN & CLARK.

Machinery used. Rand "Slugger" Drills and Rand Air Compressors exclusively.

Contract Awarded.—WASHINGTON, August 27.—The contract for the construction of a court house and postoffice at Denver, Col., was yesterday awarded to Hayes and McGuavey, of Colorado, at their bid of $59,000. Armargo Colorado stone has been selected as the material to be used.

New Stone Arch Bridge.—The amount of bonds authorized for the new stone arch bridge across the West side channel at Minneapolis, Minn., is $180,000, and this is believed to be sufficient to complete the substructure and half of the roadway, which will eventually be eighty feet in width.

Dredging Cape River.—The Farmers' Phosphate Dredging Company, of Charleston, S. C., have purchased the steam dredge *Chrisfield*, belonging to the New York Dredging Company, which has been in use in dredging the Cape Fear river, and as soon as some necessary repairs have been put upon her she will be towed to Charleston by the steam tug *Blanche*, where she is to be used in dredging for phosphate rock.

Contract for Pennsylvania R. R. New Line.—The contract for the Pennsylvania Railroad's new line from the mainland at Manahawkin to Long Branch and thence to Beach Haven and Barnegat City, has been awarded and the work begun. It will open up some twenty miles of ocean front that is now entirely unimproved. Another Pennsylvania extention along the shore is that now being made of the Anglesea road, from Anglesea to Holly Beach.

St. Paul Contracts.—At a council meeting held Aug. 25th, the award to the Twin City Improvement company of the contract for paving Robert street, from Third to Seventh streets, their bid being $15,475, was approved; also the award of the contract for constructing a sewer on Seventh street, Hoffman avenue and Third street, to William Forrestal for $11,290; also the award of the contract for grading Holly avenue, from Dale to Victoria streets, to Faber and Knapp for $1,766.

Merced Irrigation Ditch.—The work on the Merced irrigation ditch in the San Joaquin valley, California, was begun on March 13, 1883. Its entire length will be thirty-five miles, of which sixteen miles, is now completed, and for the first ten miles it is sixty feet wide at the bottom and ten feet deep, while for the rest of its length the width at the bottom is fifty feet and the depth eight feet. The company have already expended $190,000 and it is estimated that the entire cost of the undertaking will double that sum.

The Dredge Beaufort Safe.—The British steamship Ravensdale, which arrived at Beaufort, August 23, from Bermuda, contradicts the report of the loss of the steam dredge Beaufort. The Ravensdale sailed from Cardiff July 25 for Bermuda, and arrived there August 9, one day after the reported loss of the dredge in the hurricane. The Beaufort stopped at Bermuda July 28 for coal, and remained there twelve days. A letter received by a friend of one of the crew in Savannah, is dated August 6, and is postmarked August 13.

Dams.—The work of raising the dam in the Cannon river at the Polar Star mill Faribault, Minn., has been commenced. The dam is to be raised three feet. A force of men are now at work raising the road around Cannon Lake.

James B. Francis, consulting Engineer of the Locks and Canals Company, Lowell, Mass., has accepted a similar position from the Lewiston, Me. Water Company, to superintend the construction of the upper dam, confining the waters of Lake Mooseocmaguntic. Operations are to be commenced at once, that the structure may be completed before frost enters the ground. The dam was built last year, but through faulty construction was considerably damaged by the spring freshets this year. Mr. Francis has engaged Edward Lyman of Lowell, to take charge of the pumping at the base of operations.

New Docks.—The contract for building the new dock at Washburn, has been awarded to Messrs. Henry & Balch of Ashland, Wis., the same contractors that built the large coal dock. The dimensions of the new dock, upon which work is now in progress, are: Main dock, 180x237 feet, with an "L" 56x90 feet, or 47,700 square feet of additional dock. The new dock, is in connection with the large grain elevator that is to be built there this fall by J. C. Moulton & Son of Chicago. Messrs. Henry & Balch, contractors to build the dock, have contracted with Capt. R. D. Pike of Bayfield to furnish them 2,000 cords of stone.

Bids.—Concord, N. H., August 26.—A few days ago bids for the foundation and the superstructure of the government building to be erected in this city were opened in Washington. The lowest bidders were Mead, Mason & Co., of Concord. Soon after the proposals were opened Sullivan & Sargeant, also of this city, the next lowest bidders, filed a formal protest against awarding the contract to Mead, Mason & Co., alleging that they were not engaged in the line of work specified, being only wood workers. Secretary Manning directed R. H. Thayer, law clerk of the office of the supervising architect, to proceed to this city and investigate the matter. To-night he met and heard the parties interested and will report his findings to the supervising architect.

Repair of Mill Bayou Culvert.—The contract for the repair of the mill Bayou culvert, Avoyelles parish La., has been let for $2,200, $300 less than the last Legislature appropaiated for the purpose.

Contract for the Denver, Memphis and Baltimore R. R.—Contractor John Fitzgerald of Lincoln, Nebraska, is now busy on a large contract for the newly organized Denver, Memphis & Atlantic Railroad. The line is projected to extend between Denver and some point on the southeastern coast of the United States. Mr. Fitzgerald's contract called for 325 miles northwest from Memphis. He is now at work with a force of men and teams in southern Kansas. He hopes to complete many miles of the track before unseasonable weather sets in. It does not seem that the western end has yet been contracted for.

Range Lights for the Baltimore Channel.—WASHINGTON, August 27.—The officials of the Lighthouse Board expect that the range lights for the new cut-off channel at the entrance to Baltimore will be completed before winter sets in. Congress made an appropriation of $25,000 for this purpose. The plan includes two lights, the front one to be of brick eighteen feet high, and the rear one of iron 53 feet high. The plans for the structures have been approved by the board, and the contract for the metal works on the rear light has been awarded to the West Point Foundry Works, who were the lowest bidders for it. The entire work will be pushed forward without delay. It has not yet been decided whether the lights will be lenses or locomotive head-lights. The engineer recommended the former.

Index to Periodical Literature.

Electric Railroad.—*The Electric Railway in New York.*—Describes the plant and motors of the Daft company for operating the 9th avenue "L." Beginning at 14th street, a third rail is in the middle of the track and effectually insulated. The plant consists of an engine and boilers and two 50 H.P. dynamos. The motor is 14 feet 6 six inches long, 6 feet inches wide, and weighs 9 tons; a bronze wheel 14 inches diameter connects with the centre rail. The Edison & Field Co. are preparing to work the 2nd avenue "L," which also will have a third rail; but each car will have one of its trucks fitted with a motor. Illustrated. *Science*, August 21, 1885, p. p. 148, 149, 150.

Friction.—*Friction of Leather Belts on Iron Pulleys.*—A paper on the results of a special investigation of the subject. Remarks on the laws of friction, and the conclusions of different authorities. The results of 8 series of experiments are tabulated and compared, and notes made thereon. S. W. Holman, *Journal of Franklin Institute*, September, 1885, p. p. 189, to 200.

Gun.—*The Improved Gardner Machine Gun.*—Describes in detail the construction of this gun manufactured at Hartford, Conn. It consists of two B. L. rifled barrels, which are loaded, fired, and cleared of shells at each revolution of a hand crank. The firing is continuous. It is supported on a tripod. Notes on firing and trials are given. Illustrated in detail. *Engineering*, August 14, 1885, p. p. 152, 153, 154.

Lubricants.—*Machines for Testing Lubricating Oils.*—Describes the requirements for such machines, and mentions the chemical, physical, and mechanical properties to be determined in the different qualities tested. Several machines are described and illustrated. A continuous article. *Le Génie Civil*, July 25, 1885, p. p. 200, 201.

Permanent Way.—*Recent Improvements in Track.* The improvements mentioned are—the screening of ballast to free it from earthly matter; the use of longer rails; iron base plates on the ties; metal ties, and improved fastenings. 40 feet is recommended for rail lengths, and a table is given of the lengths adopted in different countries. The several improvements are fully described and illustrated. *Les Annales des Travaux Publics*, August, 1885, pp. 1409 to 1412.

Railroads.—*The Cape Government Railways.* Describes the extensive system of railroads at the Cape of Good Hope. It consists of three divisions aggregating about 1,523 miles, all on the 3 feet 6 inch gauge. Steepest grade, 1 in 40; sharpest curve. 5 chains radius. Iron superstructure largely used for culverts and small bridges; 45 pounds (on recent extensions 60 pounds) steel rails on creosoted ties; iron bowl sleepers on sharp curves. The majority of the engines are 6 coupled with four-wheeled leading truck, other types are used, including Fairlies; rolling stock includes cars of the English, bogie-truck, and Cleminson types. Details are given of cost, earnings and expenses. Map. W. G. Brounger, M. I. C. E., *Min. Proc. Inst. C. E.*, Session 1884-85., vol. lxxxi, part 3.

Strength of Materials.—*Some Tests of the Strength of Materials.* Read before the Engs. Club of Minnesota, April, 1885, by Prof. W. A. Pike. The series includes tension, compression, and transverse tests of pine wood; compression and transverse tests of bricks; and crushing tests of stone. The results are tabulated [with notes. *Journal of the Assoc. of Eng. Societies*, August, 1885, pp. 364 to 367

Tidal Waters.—*The Relative Value of Tidal and Upland Waters in Maintaining Rivers, Estuaries and Harbors.* Deals principally with the rivers Avon and Severn (England.) The mode in which the former debouches into the latter; the changes of the sand banks and channels; the action of silt; and the effects of tides and currents are described. Cross-sections of the Avon between Bristol and the river mouth are given, with tables and diagrams of velocities, etc., and a description and cut of a current meter. Other places are also mentioned. By W. R. Browne, M. I. C. E. Reproduced from Min. Proc. Inst. Civ. Engs. *Von Nostrand's Engineering Magazine*. September, 1885, pp. 177 to 195.

Recent Patents.

Cable Railway.—*Richard Gornall, Baltimore, Md.*—A draw bar is swivelled to the car platform and carries gripping jaws which engage a vertically travelling band by a spring clamp. The grip is automatically disconnected at crossings by a pin sliding in an inclined groove. The cable is cogged. No, 325,205.

Car Truck.—*John Gerhardt, Montreal, Canada.*—An arrangement for keeping trucks in position should. they leave the rails. Sliding rods are attached to the car and truck frames, sufficient play being given to allow the trucks to radiate on curves. Stops on the rods regulate the movement. No. 324, 831.

Combined Chain and Sleeper.—*P. Kirk, Worthington, England.*—The chair is formed of jaws with tenons which are welded or riveted into slots in the surface of the tie. No, 324,094.

Conduit for Cable and Electric Railways.—*W. Heysinger, Philadelphia, Pa.* Consists of yokes supporting a sheet metal tube, with the requisite sheaves, etc. The outer ends of the yoke carry the rail stringers. The tube is corrugated vertically. No. 325,174.

Electric Railway.—*Charles Van Depoele, Chicago, Ill.*—The motor receives the current from a central station, appliances being fitted for stopping and reversing, with means for reversing the brushes and converting the motor into a generator while in motion. Electric brakes are included, No. 324,899.

Electric Railway Motor.—*F. J. Sprague, New York, N. Y.*—The car carries an electric motor which propels it. The field-magnet is sleeved on one of the axles, and supports the armature which gears between the armature-shaft and the driving-wheels of the car, No, 324,892.

Method of Building Jetties.—*Roger S. Littlefield Empire City, Ore.*—A method to save the expense of piles to reach into the ground. The fill is first commenced, and piles driven into the dump thus formed; a track is laid on the piles and the filling completed around them. No. 324,857.

Submarine Wall.—*Daniel Spangler, Hanford, Cal.*—Parallel rows of piles are driven, and between them are sunk vertically removable panels, consisting of a frame forming a box which is loaded with ballast. No. 325,127.

Market Report of Engineering Materials.

New York, September 3, 1885.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.			
Angles	1.9c.	@	2.2c.
Tee	2.2	@	2.4c.
Beams and channels	3.0c.	@	
Tank	2.	@	2.1c
Shell	2.4c.	@	2.5c
Steel plates, Tank	2¾c.	@	3c.
WROUGHT-IRON PIPE., PITTSBURGH.			
Butt welded, black....Discount	47½		
" galvanized..... "	37½		
Lap welded black..... "	65c.	@	
" Galvanized..... "	47½		
Boiler tubes	60	@	
RAILS.			
Steel (large lots at mill)	28.00	@	29.00
Old rails	19.00		
Old rail steel	17.00	@	18.00
R R. spikes	1.8	@	1.9
R R. splice-plates	1.55	@	1.7.
R R. Track Bolts Square Nuts	2.75	@	3.00
Barb-wire fencing, galvanized	4¾c.	@	5¼c
" " painted	3¾c.	@	4¼c.
Corrugated iron			
Nails			
Iron	2.25		
Steel	2,40.		

METALS.

COPPER.			
Lake Superior	11¼	@	11½
Other Brands	10¾	@	11¼
LEAD.			
Com. Domestic	4.12½	@	4.15
Lead Pipe	.06¾		
Tin-Lined Lead Pipe	.15		
Sheet Lead	.06¾		
ZINC.			
Sheet	5.20	@	5.40

BRICK.

(Cargoes afloat)			
Haverstraw.....per M.	$5.62	@	6.00
Fishkill			
Up-River	5.00	@	5.50
Jerseys	4.50	@	5.50
Long Island			
" pale	2.75	@	3.25
FRONTS.			
Croton red	13.00	@	14.00
" dark	13.00	@	14.00
" brown	12.00	@	13.00
Philadelphia pressed	24.00	@	25.00
Trenton "	24.00	@	25.00
Baltimore "	37.00	@	41.00
Buff "	33.00	@	35.00
Enameled English	65.00	@	130.00
" American	85.00	@	120.00
Fire brick	25.00	@	40.00

CEMENT.

PORTLAND.			
Gibb's English 400 lbs, per bbl	2.75	@	2.90
K. B. & S. "	2.85	@	3.00
J. B. White & Bros., Portland Cement	2.65	@	3.00
do Keene's Superfine,	8.00	@	10.00
do " Coarse,	5.00	@	6.00
Roman "	2.75	@	3.50
Largerdorfer German "	2.55	@	2 80
Dyckerhoff, "	2.90	@	3.25
Stettiner "	2.60	@	2.65
Hanover "	2.60	@	2.65
Vorwohler, Lion "	2.90	@	3.25
Alsen, "	2.55	@	2.60
Fleve "	2.40	@	2.50
Saylor's American	2.15	@	2.40
Windsor } U. S. C. Co.	1.00	@	1.10
Standard } U. S. C. Co.			1.15
Cable's Portland	2.15	@	2.40
F. O. Norton Rosendale			1.10
ROSENDALE cements	.90	@	1.10

LIME.

Rockland common per bbl	1.00		
" finishing	1.20		
State, common	.90		
" finishing	1.10		
Kingston, ground	0.95		
Add 25c. to above figures for yard rates.			

STONE.

Cargo rates at New York.			
Amherst freestone, No. 1 per cub. ft.	0.90	@	95
" " No. 2 "	0.75	@	0.80
" " light drab "	0.80	@	0.95
Berlin " in rough "	0.75	@	1.00
Berea " "	0.75	@	1.00
Brownstone, Portland, Ct. "	1.00	@	1.30
" Belleville, N. J. "	0.75	@	1.25
Granite, rough	0.60	@	1.25
Common building stone per load	2.00	@	3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40	@	3.00

SLATE.

Purple roofing per square	6.00	@	7.00
Green "	6.00	@	7.00
Red "	15.00		
Black Penna. (at New York) "	4.50	@	5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00	@	20.0
Choice "	55.00	@	80.
Tally plank, 1¼ in. 10 in. dres'd. each.	.44	@	.50
Tally boards, dressed com. "	.28	@	.30
SPRUCE, Boards dressed "	.25	@	.28
Plank, 1¼ in "	.28	@	.30
" 2 in. "	.38	@	.40
" 2 in. dressed "	.43	@	.45
Timber per M.	20.00	@	22.00
HEMLOCK, Boards each.	.18	@	.20
Joist, 2¾ × 4 to 4 × 6 in.	.17	@	.44
OAK per M.	55.00	@	65.00
CYPRESS 1, 1¼, 2 and 2¼ in "	35.00	@	40.00
YELLOW PINE, Girders "	25.00	@	30,00
Dressed flooring "	28.00	@	35.00
SHINGLES, Extra shaved pine, 16 in. "	5.75	@	6.00
" sawed 18 in. "	2.10	@	2.25
LATH, Cargo rate			

PAINT.

Lead, white, American dry per lb	.04¾	@	.05
" " in oil pure "	.05½	@	.05¾
English, B. B. in oil	.08¾	@	.08¾
Red, American	.05¾	@	.05¾
Litharge "	.05	@	.05¼
Venetian red, American "	.01	@	.01¼
Indian red "	.05	@	.10
Vermillion, American lead "	.11	@	.11½
Paris green "	.15	@	.19
Umber, Amer. raw and powdered per lb.	.01¼	@	.01¾
Drop black, Amer.	.08	@	.12
" " "	.09	@	.11¾
Chrome green	.05	@	.15
Oxide zinc, American	.03¾	@	.04
" French	.06¼	@	.06¾

Pontoon Bridge.—The new pontoon railway bridge, built by the Prairie du Chien & McGregor railway company across the Mississippi river at Prairie du Chien, Wis., is now completed. The bridge was six months in building, cost $240,000 and is a marvel of strength and beauty. There are two draws, each 408 feet long. Engineers pronounce it one of the strongest and best bridge on the Mississippi river.